

**AFFORDANCES OF IPADS IN SCHOOLS:
THE ROLE OF THE EDUCATIONAL TECHNOLOGY
COACH**

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ABSTRACT

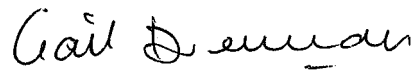
This thesis developed a research-based model of an educational technology coach. The multi-case qualitative study, founded in grounded theory, explored how five educational technology coaches helped five teachers to integrate the affordances of iPads into their teaching, through observing one- on-one sessions and interviewing participants. A conceptual framework was developed that suggested that the iPad's technological capabilities created technological affordances that led to new pedagogical affordances, for example, the camera allowed for photos to illustrate concepts. The implications of the relationships between these three concepts were described as six ways in which teachers' pedagogy can be changed: polysynchronous teaching and learning; digitised, enhanced learning compared to digital, transformed learning; student ownership of learning with teachers as facilitators; students as teachers of content and technology; and teachers' triple agendas of content elaboration, academic argument and digital citizenship. A matrix described a dependent, influenced, serendipitous and autonomous learning model that gave insight into the relationships between direct or no direct educational technology coach instruction and built-in or purchased apps. Kolb's experiential learning theory was applied to an exemplification of the work of the educational technology coach. Examples of data instantiating elements of the TPACK and SAMR models in the work of educational technology coaches showed how teachers' TPACK benefitted. Data was categorised into a framework with eight sections: teacher-driven scheduling; educational technology coaches' relationships with teachers; teacher-driven agendas; educational technology coach-driven agendas; educational technology coaches' relationships with parents; educational technology coaches' relationships with students; empowering students; teachers' relationships with students; educational technology coaches and teachers learning from others; and personal professional development. Finally, an emerging model of an educational technology coach was proposed with the underlying principle of the educational technology coach discovering how the teacher wanted the iPad or app to better his or her pedagogy. This was followed by a consideration of the resultant concepts: meeting times; knowledge of applications; multifunctional or creative apps; trialling and testing apps; student purchases; teaching about the iPad and an app; collegiality; and modelling desired behaviour.

Keywords

iPad affordances; TPACK; SAMR; Educational technology coach; Pedagogical affordances; eLearning; Grounded theory

DECLARATION

I declare that this thesis is my own unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

A handwritten signature in black ink, reading "Gail Deirdre Drennan". The signature is written in a cursive, flowing style.

Gail Deirdre Drennan
9th day of August in the year 2018

I dedicate this work to my parents, Henry and Yvonne Silburn, my husband, Robin Drennan and our daughters, Katherine Drennan and Candace Drennan, in loving thanks for their gentle insistence on and continued support of all my academic pursuits.

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LIST OF ABBREVIATIONS

ADE	Apple Distinguished Educator
ALN	Asynchronous Learning Network
BYOD	Bring Your Own Device
CK	Content Knowledge
DISA	Dependent, Influenced, Serendipitous, Autonomous
EMS	Economic and Management Science
ETC	Educational Technology Coach
FAL	First Additional Language
GIF	Graphics Interchange Format
ICT	Information and Communication Technology
IEB	Independent Examinations Board
ILT	Information Learning Technology
iOS	iPhone (and iPad) Operating System
IT	Information Technology
IWB	Interactive White Boards
LMS	Learning Management System
MOOC	Massive Open Online Course
ORT	One Research Task
OS	Operating System
PC	Personal Computer
PCK	Pedagogical Content Knowledge
PD	Professional Development
PK	Pedagogical Knowledge
PNG	Portable Network Graphics
PTK	Pedagogical Technological Knowledge
QR	Quick Response
SAMR	Substitution, Augmentation, Modification, Redefinition
TCK	Technological Content Knowledge
TK	Technological Knowledge
TPCK	Technological Pedagogical Content Knowledge
TPK	Technological Pedagogical Knowledge
UNISA	University of South Africa
USB	Universal Serial Bus
USF	University of San Francisco
VPN	Virtual Private Network

INTRODUCTION

Teachers in formal school education have always used some form of technology in their teaching, from blackboards to whiteboards, from gelatine hectographs to photocopiers and a host of others. Early personal desktop computers allowed individuals to write and print documents with some limited formatting being possible. The rise of the Internet made it easier for documents and scanned images to be shared digitally and later for simultaneous and asynchronous online collaboration to be realised. Laptops enabled device and work mobility with digital and online work being done outside of school hours and buildings. While the release of the iPad 1 in April 2010 allowed for greater mobility because of its smaller size, extended battery time and touch screen as compared to laptops, it was the iPad 2, with its camera, that could be regarded as the game changer, as it afforded previously unimagined change to teachers' pedagogy. Also, unlike other technologies, it could enable students to play a more active role in their learning as the power dynamics in the classroom are more open to transformation.

Background to the study

Tablet computers, particularly iPads, have been at the forefront of educational debate over the past few years. Many research studies have investigated how mathematics and science teachers in particular have used specific applications (apps) in their classrooms. The researcher wanted to investigate how a teacher with a more focused approach, an educational technology coach (ed tech coach), used the affordances of iPads to help teachers integrate them into their teaching. This is broadly in line with one aspect of the South African government's 2003 National Development Plan, in which technological innovation, training and skills development is seen as a core component. At this early stage, the researcher realized that there might be a gap in the literature. I did not find anything that could shed light on the way in which ed tech coaches helped teachers to integrate iPads and their affordances into their pedagogy. In South Africa this is partly due to the dearth of formally appointed ed tech coaches in public and private schools.

In South African ed tech coaches are a recent addition to the staff of some schools, predominantly those in the private sector. There is no government mandated job description, neither is there a training course, nor are there any agreed upon standards

against which they could be assessed. Furthermore, they do not teach a matriculation subject, so the final school examinations cannot be used to reveal their standard of performance. One way to assess their efficacy might be through the performance management of staff development. Additionally, few teachers have the Information Technology (IT) skills to make the transition to becoming an educational technology coach (ed tech coach) easily, while IT specialists usually lack the necessarily requisite teaching background. It would appear as though teachers are appointed as ed tech coaches on the basis of their having an interest in IT integration and their reputation for using computers in their classroom, by a principal who can see the value of up-skilling staff, but their backgrounds, training and experience vary widely. With exposure to the teaching practices of only one ed tech coach, I wondered how others used the affordances of iPads to up-skill their colleagues.

The scope of the study meant that my narrow focus was on a well-resourced Independent Examinations Board (IEB) private school, rather than on both public and private schools. It was further hoped that focusing on a school using iPads would limit technologically confounding factors that might bedevil analysis if the school allowed a multiplicity of devices.

As the girls' high school librarian at a well-resourced private school, I have shared an office, since 2013, with a then newly appointed girls' primary school ed tech coach. This educator is later referred to as Educational Technology Coach 3 (ETC3). Her passion for using the affordances of iPads to help teachers integrate them into their teaching was inspiring and infectious. She was generous to a fault and shared her expertise willingly and freely with all who asked for help: teachers; pupils; parents; and Information Technology (IT) staff, both within and without her school. This could not but rub off on me, previously a technological Luddite, whose interest grew through observing her coaching sessions with individual teachers and with departmental groups, in our shared library office.

Indisputably, teaching is a demanding profession and teachers have tightly time-constrained lives. This is particularly true of high school teachers who prepare their students for the matriculation examinations. High schools stand on their matriculation results. Reputational risk, often associated with the introduction of new technology, is anathema to many teachers. For a variety of reasons they are reluctant often to spend the time and effort to implement technology unfamiliar to them. Watching ETC3 dealing with her colleagues I began to see the impact she had in turning technologically resistant

teachers into confident ones who successfully integrated iPads in their teaching. Her role as an ed tech coach allowed her to draw on her 18 years of computer and teaching experience and to present integration ideas and specific apps to teachers that might help them to change their pedagogy.

iPads and their apps

In a few South African schools teachers and students have started using iPads in the classroom. In addition to the extensive range of built-in apps that enable iPads to be used in a substantive number of ways after purchase, without the necessity for downloading or buying further apps, an ever expanding complement of apps continues to be developed that teachers could exploit, some especially designed for educational purposes. Broadly speaking, the apps fall into two categories: content specific apps and multifunctional or creative apps. A content specific app, such as SpellBoard, permits the input of vocabulary words by teachers or students. Various game-type activities, such as word searches and letter unjumbling, as well as practice tests that could be taken innumerable times, allow students to practise their spelling, importantly with or without the teacher's help. These apps have a dedicated function and cannot be used to achieve a wider range of purposes. On the other hand, multifunctional or creative apps, such as Book Creator, are really a template for teachers or students to input their own text, images, sound or videos to create learning materials.

These apps, especially when used in conjunction with the camera added to the iPad 2 that was released on 2nd March 2011, enabled a far greater range of teaching activities to take place, as well as allowing teachers and students to create and share their own materials. Prior to this, the power dynamics around access to resources resided solely with teachers. It was taken for granted that deciding which resources, if any, were to be used in the classroom, was within their professional purview. Teachers were also responsible for developing and deploying such resources as was necessary. Now the power dynamics could be radically altered. Both teachers and students could have access to exactly the same apps on the same devices. Students could be as likely as teachers to find new apps or to use an already downloaded one in a new way. Students could use the iPad to find, create or present content themselves. Teachers would still need to facilitate the process and assess the product, as well as teach those lessons in which they chose not to use an iPad, but the hierarchical nature of teaching could be completely disrupted. For the first time, teachers and students could operate more as

educational partners.

However, few teachers seem to have the time or skill to fully implement the affordances of iPads, even if they are so inclined. The field of eLearning has an interest that centres on the relative merits of teaching about technology or teaching with or through technology. This study hopes to show that teaching with or through technology, specifically with iPads, brings about significant and lasting change. In other words, when a dedicated ed tech coach helps teachers to implement iPads and their affordances in their teaching, the expectation is that those teachers' pedagogy is changed for the better. Furthermore, without the intervention of ed tech coaches, teachers do not receive the type of professional development that leads to the effective, co-ordinated and sustained implementation of the affordances of iPads in schools. It is postulated that without this help teachers might not use the iPads in ways that are beneficial academically or in ways that improve their pedagogy.

The possible role of an ed tech coach

If there is no dedicated staff member employed as, or acting as, an ed tech coach, then it is most probable that an interested teacher, most likely one with a strong interest in computers generally, would begin to investigate and implement the educational affordances of iPads. It is further likely that their explorations and the consequent demand for help from fellow teachers in implementing such affordances, would inevitably create a conflict with a teacher's time and focus that might overwhelm the capacity of the teacher to undertake two such disparate roles successfully at the same time. The teacher and the principal would need to discuss which role is the more important. It also likely that private rather than public schools in South Africa would be best placed to take on the costs of an ed tech coach being appointed as an additional staff member. This study argues that it is only through the professional development undertaken by ed tech coaches that the affordances of iPads would be fully realised in schools. Without this intervention it seems unlikely that such professional development would happen in a deliberate manner leading to the implementation of technology in a seamless, ubiquitous and taken for granted way. This professional development could address both a first-order or external challenge that Ertmer (1999) raised, as well as a second-order or internal challenge, teachers' perceptions of themselves, their students and the technology.

This is not to imply that the affordances of iPads are poorly signalled or require

much training to use. There might be two factors preventing teachers from utilising them effectively: lack of time and an unwillingness to change pedagogy, but an ‘apprenticeship’ in their pedagogic use seems necessary. It is suggested that both of these factors could be dealt with by an ed tech coach who gains the trust of his or her teachers, through scheduling regular sessions and holding teachers to account for their learning, in effect helping them to serve such an apprenticeship.

At this point, it is necessary to note that there is no single title used in the literature to refer to staff members who undertake this role. While there may be others, the researcher is aware of five titles. Articles in the literature have referred to Digital Integration Specialist, Technology Integrator and to the more cumbersome Information Learning Technology coach. This study used the term Educational Technology Coach shortened to ed tech coach, and abbreviated to ETC or C4, for example, in the transcripts and data analysis, as that was the term used by the participating school. However, since the conclusion of the data gathering and analysis, the five schools, incorporated as one school, took a decision to change the title from Educational Technology Coach to Digital Learning Coach as a more accurate reflection of the role. I decided to keep to the title of ed tech coach rather than change all the times that designation was used in the transcripts and this thesis for purposes of continuity.

It may be that the fluidity around the title reflects the changing nature of the role. The term technology alludes to hardware and software issues that are resolved by IT technicians. By removing the term technology from the title ed tech coach and replacing it with digital learning coach it is hoped that staff will refrain from viewing the ed tech coach role as one of technical support. When computers first came into schools, there was a need for a dedicated computer teacher. This person was often the ITC co-ordinator, in other words, one person who managed the hardware and software issues and the teaching of the IT curriculum. Through necessity, the role evolved when the number of devices in schools increased and there was a realisation that one teacher in one computer lab was redundant as IT was no longer a separate subject but formed part of the way in which students learn and are taught. This decentralisation due to the proliferation of mobile devices brought about a need to shift the focus from ITC co-ordinator in a computer lab to an ed tech coach able to help teachers and students with mobile learning.

It was while working in the same office as a newly appointed ed tech coach, an

interested teacher with a strong background in computers, over about two years that led to the realisation that it might be the ed tech coach who empowered teachers to change their pedagogy. This is reflected in the words of David Guerin, principal of Bolivar High School, MO, USA, and author of “Future Driven: Will your students thrive in an unpredictable worlds?” who wrote in his blog that “Classrooms don’t need tech geeks who can teach; we need teaching geeks who can use tech.” (The David Guerin Blog, 19 November 2015).

Researching the role of ed tech coaches

Having become interested in the work of ed tech coaches it was necessary then to determine what the possible purpose of a research study might be. Outcomes such as emancipation through symbolic partnership, discovery of knowledge or prediction were not appropriate. It was decided that allowing data to emerge from the field in which clarity on this issue was still being sought, might allow for descriptions that would shed light on what it is that ed tech coaches do and how they contribute to changing teachers’ pedagogy in the main. Accordingly, it was decided that the research question would be how do educational technology coaches use the affordances of iPads to help teachers integrate them in their teaching in well-resourced Independent Examination Board schools?

MAPPING OUT THE THESIS

The thesis is set out as follows. CHAPTER 1: CONCEPTUAL FRAMEWORK argues that the iPad's technological capabilities create technological affordances that lead to the development of new pedagogical affordances. A conceptual link is postulated between the technological capabilities, technological affordances, and pedagogical affordances of the iPad. Technological capabilities refer to the built-in elements of an iPad, such as the camera. Technological affordances show how these capabilities could be used, for example, through using the camera to take a photo. Pedagogical affordances refer to the use of technological affordances for pedagogical purposes, as when a photo is used to illustrate an educational concept. A conceptual framework is then presented outlining some of the relationships between these three concepts. This is followed by a theoretical conception of six ways in which the iPad's technological affordances can create new pedagogical affordances and change teachers' pedagogy: polysynchronous teaching and learning; digitised, enhanced learning compared to digital, transformed learning; student ownership of learning with teachers as facilitators; students as teachers of content and technology; and teachers' triple agendas of content elaboration, academic argument and digital citizenship.

CHAPTER 2: LITERATURE REVIEW ON AFFORDANCES explores affordance theory in general, with consideration of both the TPCK and SAMR models. In turning to the affordances of iPads, both positive and negative aspects of its usage are scrutinised, as well as aspects of its usage by teachers and ed tech coaches. A matrix is presented giving some insight into the relationships between direct or no direct ed tech coach instruction and built-in or purchased apps. The resultant four categories are named as the Dependent, Influenced, Serendipitous and Autonomous relationship categories, thus the whole is called the DISA matrix. It ends with an exemplification of Kolb's experiential learning theory through the work of ed tech coaches.

CHAPTER 3: METHODOLOGY deals briefly with aspects of qualitative research. It provides greater depth on the research strategy, purpose and design of the multi-case study. Normally coding is used as a data analysis technique but the researcher used categories arising from the data to achieve the same end. Further detail is given in the four sections headed Selection of the Schools and Participants, The Three Phases of the

Research, Audio Recording and Data Collection and Transcription.

CHAPTER 4: INSTANTIATING LINKS BETWEEN THE TPCK AND SAMR MODELS AND THE DATA gives examples of data instantiating elements of the TPCK and SAMR models. It contends that when ed tech coaches use the SAMR model to build teachers' PK or TK through their CK this strengthens their TPCK and has other benefits for teachers and students as they both work in different ways. A mobile device on which they can work online or offline enables them to learn with ubiquity, flexibility and sophistication. Teachers can offer extension and remediation, while students can work with greater confidence, independence and control over both the process and product of their work.

CHAPTER 5: PORTRAIT OF AN EDUCATIONAL TECHNOLOGY COACH starts with the backgrounds of the ed tech coaches and the method of transcript analysis. The rest of the chapter is devoted to a combined analysis and description of the data. The data is categorised as ten major findings:

1. Teacher-driven Scheduling
2. Ed Tech Coaches' Relationships with Teachers
3. Teacher-driven Agendas
4. Ed Tech Coach-driven Agendas
5. Ed Tech Coaches' Relationships with Parents
6. Ed Tech Coaches' Relationships with Students
7. Empowering Students
8. Teachers Relationships with Students
9. Ed Tech Coaches and Teachers Learning from Others
10. Personal Professional Development

Each finding is discussed in depth with pertinent, supporting examples from the interviews and observations.

CHAPTER 6: AN EMERGING MODEL OF AN EDUCATIONAL TECHNOLOGY COACH pulls one underlying principle out of the ten major findings. This principle is framed as Changing the Teacher's Pedagogy. In essence, it is the ed tech coach finding out how the teacher wants the iPad or app to change his or her pedagogy for the better. This is followed by a consideration of the five principles that result from this underlying one: Meeting the Teacher's Needs; Knowledge of Applications; Collegiality; Modelling Desired Behaviour and Meeting the Students' Needs.

CHAPTER 7: CONCLUSION briefly reviews the role that grounded theory played in this study. Then consideration is given to one concern in the analysis of eLearning. The major tables are repeated to summarise the study. Finally, the conclusion is reached that vision, escalation and critical mass are the three hallmarks of the success of an ed tech coach.

To start, we turn to the conceptual framework that introduces the three concepts of the iPad's technological capabilities, technological affordances and pedagogical affordances, as well as their relationships and the implications this has for pedagogical change.

CHAPTER 1: CONCEPTUAL FRAMEWORK

Many studies have considered how educators use iPads in their teaching. However, little research has looked at how teachers' pedagogy has changed through this usage. The researcher attempts to delineate a conceptual understanding of how teachers do this. She argues that the iPad's technological capabilities create technological affordances leading to the development of new pedagogical affordances. The argument is made in two ways. Firstly, specific examples of these three concepts are articulated to clarify some of their relationships. Secondly, the pedagogical affordances are discussed as six broad strands illustrating how teachers' pedagogy can change, in some instances when filtered through the TPACK and SAMR models. Each discussion strand lists specific benefits for teachers, students and parents.

The literature on educational tablet use has focused on their use by classroom teachers, concentrating on affordances available to teachers, and apps used, especially since the 2010 introduction of iPads. While teacher pedagogical practices is well researched, especially as "access to resources are no longer the most substantial barriers to the integration of technology in schools (Jodoin, 2013, p. 46), little has been written about how teachers' pedagogy has changed, with a concomitant "lack of innovative pedagogical guidelines" (Nguyen, Barton, & Nguyen, 2014, p. 8). Valstad and Rydland (2010) decry leaving the iPad integration decision to individual teachers. Reid and Ostaszewski (2011, p. 51) reveal an early change in pedagogy, using the "iPad as a mobile multimedia demonstration device" to teach Ukrainian dance, especially "gender-specific movements...and student-controlled playback-and-practice activities". I attempt to delineate a conceptual understanding of how teachers use iPad affordances and applications, and how this might influence students, and their families. It partially rebuts Murray and Olcese's (2011, p. 48) assertion of a "dearth of good examples of the applications of technologies that are either built on or support anything more than a behaviourist or proto-cognitive theory of learning."

I postulate a conceptual link between the technological capabilities, technological affordances, and pedagogical affordances of the iPad. Technological capabilities refer to the iPads' built-in elements, such as the camera; technological affordances shows how these capabilities are used, for example, using the camera to

take a photo; while pedagogical affordances involve technological affordances as used for pedagogical purposes, for example, when a photo is used to elucidate an educational concept.

Then I demonstrate two ways of showing how the iPad's technological affordances create new pedagogical affordances. Firstly, a table matches some capabilities to some technological and pedagogical affordances. Secondly, a conceptual discussion of six ways in which teachers' pedagogy can change, with details of possible examples from the perspective of teachers, students, and parents, is presented.

The structure is as follows. Affordance theory briefly provides context, then pre-tablet Information and Communication Technologies' (ICTs') educational affordances are discussed. Next tablet affordances are examined, followed by a table linking the iPad's technological capabilities, technological affordances, and pedagogical affordances. Subsequently, a theoretical conception of six ways in which iPad technological affordances can create new pedagogical affordances, and change pedagogy, is considered. The conclusion is advanced that teachers can use these relationships to develop their TPACK (Technological Pedagogical Content Knowledge), especially through using the SAMR model, and that there are six advantages for teachers, students, and parents, when teachers incorporate these affordances into their pedagogy.

A Brief Overview of the Foundations of Affordance Theory

Gaver's (1991) work, on the importance of affordance signalling in design foregrounds the relevance of the match between intended and actual use that makes tools easy to use. Norman (1999, p. 42) characterised "affordances as reflecting...the possible relationships among actors and objects". His focus is on the actor's "mental and perceptual capabilities" (McGrenere & Ho, 2000, p. 3), as well as on the design of the tool, as the driving force behind an actor's perception of affordances. However, Hammond (2010) asserts that we see affordances through our interactions with objects, while Gibson (1986) holds that our perception of affordances reveals our perception of ourselves; both authors concentrate on actors and actions.

To some extent, this relationship between actors and actions is pre-figured in the semiotic work of Vygotsky, who theorised that signs mediated human interaction with the environment, specifically cultural artefacts. These signs provided them with affordances, although Vygotsky did not use this term, enabling them to think and act conceptually as these "communicate cultural knowledge and organise the behaviour of

every individual” (Linask, 2012, p. 202). Signs reveal concepts and their relationships. Actors who understand the signs act through them as they also afford potential actions.

It is possible to map Vygotsky’s concept of the developing mind of the child being “intertwined with specific systems of tools and signs” (Linask, 2012, p. 204) to the mind of the tablet user being intertwined with device-specific tools and signs. As these tools and signs are socially developed they become the conventions that must be learned in order to act effectually with or through them. To paraphrase Linask (2012, p. 205), it is these tools and signs that enable humans “to use (their) environment to (their) benefit” unlike animals whose actions are “mostly determined by the conditions of the environment”.

To understand how a tool or sign can be used implies that the actor understands how it mediates the environment. In other words, action depends on the symbolic environment that depends on the direct environment (Linask, 2012). Signs mediate symbolic activity. Linask (2012, p. 207) states that “signs mediate the transmission and accumulation of knowledge in cultures from one generation to the next... (making) continuity...possible” and so assimilate a child into cultural membership. However, cultural transmission seems to imply a downward flow from adult to child. It is one of the contentions of this thesis that the iPad can allow for an upward flow of cultural transmission from child to adult of the signs needed to mediate its usage in the classroom. This is discussed in several places in Chapter 5: Portrait of an Ed Tech Coach but can be found specifically under the sections headed “Teachers’ Relationships with Students” and “Ed Tech Coaches and Teachers Learning from Others”. In this sense, it is the child inducting the adult into cultural conventions and technological membership and not the other way around. Furthermore, the visual elements of the iPad can allow for users to transcend cultural bonds arising from language, geographical region, political system or generational cohort. In some way it allows for the democratisation and sharing of experience, building bonds between people who only know each other in the digital realm.

Laurillard, Stratfold, Luckin, Plowman and Taylor (2000) frame the relationship between a user and an educational multimedia computer program as being one of interactive collaboration that gives rise to a narrative structuring. They characterise affordances as the “internal relation between the perceiver and the perceived” and reiterate Gibson’s point that “what we perceive when we look at objects are their affordances, not their qualities” (2000, Para. 4). This could lead to the deduction that

perception can result in a particular action whether or not this is in accordance with the designer's intentions. As Gaver (1991) foretold, they note that "Affordances cannot be easily disassembled into predictable cause-and-effect descriptors that can be counted and correlated...as they are possibilities fulfilled, potentials achieved," concluding, "the affordance made possible...is completed by the students' interpretation and use of it," (Laurillard et al., 2000, Para 36) suggesting that different actors might perceive and act differently when confronted with the same affordance. In pedagogical terms, an affordance can be seen as the extent to which an artefact enables a person to act or achieve their ends. In terms of this study, the artefact would be the iPad and the affordances would be the extent to which an ed tech coach used it to transform a teacher's practice.

McGrenere and Ho (2000, p. 2) articulate the relationship between actions and affordances as "the actor-environment mutuality... [of an] inseparable pair". They agree with Gaver that affordances are actor-independent, but usability depends on an actor's knowledge, experience, and culture. The researcher would include social identity and purpose, as Rietveld and Kiverstein (2014) argue that affordances are embedded in socio-cultural practices, and that they depend on specific contexts and skill levels. Dubé and McEwan (2016) refer to Orlikowski's term, constitutively entangled, to refer to this affordance-user nexus.

With computers, Norman (1999) distinguishes between physical affordances, such as the keyboard, and perceived affordances represented by graphic conventions, such as the cursor. Oliver (2005) extends Norman's point about actors' understanding such conventions, to include the learning of symbols, signalled in different ways. Kennewell (2001) advances Hammond and Greeno's postulation of constraints as being the obverse of affordances, asserting that affordances provide action through constraints that provide structure. Nevertheless, Kennewell (2001) observed ICTs as having peculiar classroom affordances, where they do not act independently of other classroom variables.

Affordances of Pre-tablet ICTs in Education

The pre-tablet work of Conole and Dyke (2004) drew on early iterations of online tools, such as those for communication, writing, and learning management. They were concerned with the expression of affordances, the compilation of these into an ITC taxonomy, and their application in education. They listed ten areas of benefits for teachers' pedagogy, and the changes organisations need to make to accommodate these.

The researcher argues that three of these (speed of change, monopolisation, and surveillance) fall into the domain of organisational change, while the rest (accessibility; diversity; communication and collaboration; reflection; multimodality and non-linearity; risk, fragility and uncertainty; and immediacy) lie more under teachers' control. These necessary but insufficient issues fail to consider how teachers' pedagogy is changed.

Before tablets, there was a small range of ICT devices, each with their own affordances; personal computers (PCs), interactive white boards (IWB), clickers, data projectors, and iPod Touches. Firstly, PCs whether desktops or laptops, were available in school computer laboratories for students. In one thirty- or sixty-minute lesson per week, students learnt simple word processing skills, such as creating documents (see Cox, Abbott, Webb, Blakeley, Beauchamp, & Rhodes, 2003), or did mathematics drills. Secondly, if teachers had a PC, connected to an IWB, they could present more visually stimulating lessons than those using a chalkboard or overhead projector. Teachers or students could write on the board without typing on the computer, and print the material that had been displayed. Cox et al. (2003) and Meyer (2013) bemoaned the prevalence of restrictive ICT usage, such as IWBs being controlled by the teacher, and used solely as electronic chalkboards. However, Agostini and Di Biase (2012, p. 47) concur with Schmid's conclusion that "using IWB for literacy and mathematics in primary schools underlines that children are more motivated in lessons because of the high level of interaction and discussion." Thirdly, if teachers had clickers (individual, remote, classroom response system devices), they could poll students anonymously and tabulate their responses to multiple-choice questions on the teacher's PC. With a PC-linked data projector, teachers could show videos, especially if there was Internet connectivity, although this did not allow for teacher or student interactivity with the video.

Before students had PCs, the iPod Touch allowed for the greatest teacher and student interaction, since it overcame "the challenges of presenting content in audio and visual formats" (Reid & Ostashevski, 2011, p. 49). In 2009, the then Hayward School, now Essa Academy in Bolton, England, gave each student an iPod Touch. From the first year, it was a major trigger in turning the schools' failing results around. The Wi-Fi-enabled devices were used to make notes, email work, complete administrative tasks, and revise for exams. They allowed direct access to educational information through teacher created podcasts, and to Apple's App Store, but not the Internet. In a school with a large refugee population and about 40 mother tongues, the dictionary and thesaurus apps improved students' English without leaving class to attend language lessons. Students

also read up on the basics of a topic in Wikipedia in their home language. Subject-specific apps enabled teachers to present material in different ways. Chohan (2012, para 13) revealed, “in English lessons...teachers used the *Shakespearean Insults* [emphasis in original] app as a fun way to familiarise students with the barbed language of the Bard. The *Elements* [emphasis in original] application brought the periodic table to life in science classes.” He disclosed some suggested apps, which both helped technophobic teachers and boosted student self-worth. The final section elaborated on how students influenced teachers, and changed their pedagogy. In comparison with the other devices, the iPod Touch allowed for the greatest interactivity and flexibility between teachers and students, foreshadowing the introduction of tablets.

Tablet Affordances in Education

The broader literature has not looked in depth at the affordances of tablets in general, as most deals with iPads only. Nguyen et al., (2014, p. 1) ascribe this to the “fast and wide uptake of iPads among the younger generation of students and academics.” Nonetheless, in considering post-PC tablets, Godsk (2013) focused on iPads, Android tablets, Blackberry Playbooks and HP Touchpads. Without differentiating between them, he listed, with supporting studies, the top 10 affordances as: engaging inclusive and or collaborative learning; mobility or flexibility in place; use of multimedia or interactive content and apps in teaching; student satisfaction; personalisation and student-centered learning; use of e-books; resource saving; flexibility in time and place; eco-friendliness; and resource competitiveness. The researcher agrees that the first five are the most important. The implications of their impact on teachers’ pedagogy are discussed later.

When teachers and students, used to webOS, or the operating systems of Windows, Android, or Blackberry, change their paradigm to engage with the iPad, they rapidly appreciate its intuitive design, high levels of usability, and the ease it affords in switching between applications (Golland, 2011), amongst other affordances applicable to all tablets.

Intuitive design can be particularly important in helping teachers use the iPads affordances quickly and easily. Only a few minutes are needed to show the position and functions of the external controls: the on/off button, the headphone jack and microphone on the top; the speaker and dock connector slot on the bottom (to charge, synchronise or connect to a projector or TV); and the volume button on the right; the touchscreen and app icons, the home button and front camera at the front; and the back

camera at the back. Another few minutes are needed to show the finger movements and their effects: tap; hold; swipe; pinch; pull; drag; deep touch; and multiple touch. Work done on the iPad is saved automatically in the app, but there is an option for Folders. Another intuitive feature, storing photos as thumbnails, removes the need to name every photo. Further, users can save photos in Events, Favourites or Albums, in addition to the automatic chronological storage that makes it easier to search through them. Later models also use facial recognition to retrieve photos. Anecdotal evidence suggests that touchscreens seem particularly easy to use, as people are accustomed to manipulating objects directly with their fingers rather than through an intermediary such as a mouse. If a teacher forgets a specific movement, he or she is likely to tap or double tap to solve the impasse, which it often does.

The major affordance of video capability can increase social capital. Quidwai and Norman (2016) tasked trainee physician assistants with creating videos, rather than writing a paper, about the community surrounding Keck Medical School, and their potential future professional engagement with such. This dramatically changed student empathy levels, sensitising them to challenges facing those dependent on state-provided health care, and to their role when dealing with people from backgrounds different to their own.

Haßler, Major, and Hennessy (2016) considered all tablet brands in reviewing evidence on students' learning outcomes. They found support for teachers using "transformative pedagogical models" (Haßler, Major, & Hennessy, 2015, p. 16) to positively change learning outcomes, and for tablet use in many-to-one situations, that resulted in "superior artefacts as all the notes were well discussed" (2016, p. 15), when compared to the increased interaction, communication, and group communication of one-to-one situations.

Traxler (2010) warned about the quality assurance difficulties educational providers, especially universities, could face if students used any mobile device. He cited a pilot study showing students were not likely to "value a second device, an anonymous university-provided device ...that did not express their taste or aspirations and...would inevitably be the one left at home" (Traxler, 2010, p. 157). The perils and problems of a Bring Your Own Device (BYOD) policy can be a strong argument in favour of tablet standardisation.

iPad Affordances in Education

Heinrich (2012, p. 9) notes the dominance and educational value of the iPad, as the device of choice, when compared to Android devices, because of the “consistency of the operating system and interface and the availability of educational apps”. This level of reliability leads to the bold statement that “iPads therefore became significant actors in moving school development in the direction of a more innovative and ubiquitous use of technology” (Reed, 2013, p. 261). Compared to other tablets, Meyer (2013) affirms the iPads’ lower maintenance costs. Clarke and Abbott (2016, p. 1061) reiterate Copeland’s observation that iPad “ICT skills were acquired without necessarily being taught first”. This might seem unrelated to affordances or pedagogy, but it can be found to relieve teachers of a significant technical burden, such that teaching and learning remains uninterrupted.

Lane (2012, p. 4) orients iPads as “multi-modal ‘convergence’ tools [for]... researching, producing, communicating, teaching and learning”. Valstad and Rydland (2010, p. 25) align this with Mayer’s modality principle that multimedia, rather than visual, presentation results in better learning and application. Karsenti and Fievez’s (2013) comprehensive survey enumerates 16 main benefits for students using iPads, including allowing “a wider range of teaching strategies... [and] pedagogical support”. Clarke and Abbott (2016) endorse the benefits of iPad apps reinforcing traditional pedagogy. Cochrane, Narayan, and Oldfield (2013) furnish details of links between iPad capabilities, social constructivist pedagogy, and the application of affordances for business, architecture, music and engineering tertiary students.

What are the Links between the Technological Capabilities, Technological Affordances, and Pedagogical Affordances of the iPad?

It is useful to see the technological capabilities of the iPad as the built-in design elements: size, portability, touch screen, battery life, accelerometer, cellular connectivity, and camera; as well as installed apps such as email, web browser, calendar, and the note, slide and video-making programmes. Technological capabilities become technological affordances when they are used; for example, using the camera to take photos or videos. The pedagogical affordances are the way teachers and students use the technological affordances to meet educational goals where purpose determines such classification. A person might use the camera (technological capability) to take a photo (technological affordance) of a flower to record its beauty. However, the same person might use the camera (technological capability) to take a photo (technological affordance) of a flower to

show leaf arrangement (pedagogical affordance). The purpose to which the technological affordance is put determines whether or not it is categorised as a pedagogical affordance. The discussion now turns to the tabulated description that gives specific examples of these three concepts to clarify some of their relationships.

A Tabulated Description Matching Some of the iPad's Capabilities to Some of its Technological and Pedagogical Affordances

This is not an attempt to match all capabilities with affordances, as teachers and students are endlessly creative, and no exhaustive listing of them will ever be possible. The researcher hopes to categorise some obvious ones.

The table leads the discussion, secondly, onto a more general and overarching theoretical approach to six ways in which teachers' pedagogy can change, in some instances when filtered through the Technological Pedagogical Content Knowledge (TPCK) and Substitution Augmentation Modification Redefinition (SAMR) models. Each strand of the discussion gives detailed examples from the point of view of the different school stakeholders, namely teachers, students, and parents. The letters A to I in parentheses next to each sub-heading refer to the nine capabilities listed in Table 1, and are intended to show which capabilities are most relevant for each strand of the discussion.

Table 1: A Conceptual Framework: Matching Some Specific iPad Capabilities to Some of its Technological Affordances and Pedagogical Affordances

iPad capability	Technological affordance	Pedagogical affordance
A) Size	Portability	Learning is ubiquitous, flexible, polysynchronous
B) Long battery life	No need for a power cable	Mobility of teachers and students, inside and outside of classroom
C) Touch screen	Direct interface	No mouse, no external keyboard or track pad Keys do not stick
D) Intuitive interface	Quick and easy to learn	Tap and swipe Teach with and through, not about, tech Student gurus Team-teaching and material development
E) Integrated audio and video	Make and play back audio and video recordings Access to worldwide resources	Movie or audio recordings Authentic learning Virtual stage Sophisticated presentations Written or spoken comments Teacher carries little home Flipped classroom Special needs learners Digital textbooks
F) Guided access	Temporarily restrict to	Stay on task

	single app Choose which app features are available Disable hardware buttons	Disable task irrelevant screen areas Prevent accidental gesture distractions
G) Apps	Seamless integration	Document and resource sharing makes collaborative work easier Learner construction of material Heutagogy
H) Apple TV¹	Share screen of one iPad to whole class	Whole class sees peers' or teacher's work whether text, audio, or visual
I) Apple classroom¹	Monitor and manage iPads	Only teacher can see what each student is doing Teacher sends or receives work through any app to or from individuals Teacher corrections

¹ Apple TV and Apple Classroom recall “the teaching machine allows the teacher to supervise the entire class while facilitating differentiated learning” (Skinner, cited in Spark & Sackstein, 2014, p. 1009). This does not support a behaviourist perspective, as using either reformulates the teaching machine idea.

A Theoretical Conception of Six Ways in which the iPad's Technological Affordances can Create New Pedagogical Affordances and Change Teachers' Pedagogy

The unique strengths of the iPad are the stable operating system, intuitive interface, seamless app integration, and continuous support provided by Apple through teacher-led workshops. Although the workshops are not discussed here, the others can change pedagogy, as raised by State of New South Wales (2012), and strengthen teachers' TPACK (Mishra & Koehler, 2006). Changed pedagogy can lead to students' developing Trilling and Fadel's (2009) 21st century skills of thinking, problem-solving, communication, collaboration, creativity, and innovation, rather than passive consumption of texts, videos, and games. The Learning Exchange (2011) has more on iPads and critical thinking and problem solving. Ironically, students are not likely to achieve these skills unless teachers deliberately integrate them into their teaching (see Krauslopf, Zahn, & Hesse, 2012; Attard, 2013; Lange and Meaney, 2013; McFarlane, 2013; Spark & Sackstein, 2014; and Geer, White, Zeegers, Au, & Barnes, 2015). Saul Rockman declares “what a teacher does with *it* is more important than what the *it* is” (Cuban, 1993, p. 7, emphasis in original; see also Joy and Garcia, 2000; Foo, Ho & Hedberg, 2005). Sackstein (2014) contrasts the contexts of product and idea technology. Redman, Carlin, and Jakab (2013) concur that the iPad supports rather than replaces good teaching.

Technology does not teach, teachers do, therefore, how can teachers use iPads to teach? They are required, in Darling-Hammonds' (2006, p. 305) words, to “become

adaptive experts who can continue to learn”. Cowan and Earls (2016) highlight staff training and collaboration time with school digital mentors. Bansavich (2011, p. 17) requires “faculty...be viewed as change agents”. Nguyen, Barton, and Nguyen (2014) value academics modelling iPad usage.

This discussion now leads to a conceptual discussion of six ways iPad technological affordances can create new pedagogical affordances.

Polysynchronous teaching and learning (A, B, C, D, E, G)

“Polysynchronous learning refers to a mix of face-to-face, asynchronous, and synchronous channels of online communication” (Johnson, Adams Becker, Cummins, Estrada, Freeman, & Hall, 2016, p. 12). Firstly, pedagogy changes when the iPad is used as an all-in-one device. Students complete “different tasks with the same tool, such as taking photos, inserting them into movies or comic strips” (Redman et al., 2013, p. 129). Secondly, students receive tasks from the teacher electronically, find relevant online resources, complete the task through an appropriate app in the required format, submit completed digital work, and receive written or verbal comments digitally. Class facing boards, printing or photocopying machines, even stationery become irrelevant. Through condensing teaching functions in time and space, the iPad has simplified and extended the capability of both teacher and students, fulfilling Cuban’s (1993) promise of productivity, and meeting Murray and Olcese’s (2011) technological significance criterion that users can become more productive. Polysynchronous education ensures uninterrupted teaching and learning. Teachers and students need not inhabit the same physical classroom at the same time, where this form of teaching “allows a shift away from the industrial era model” (State of New South Wales, 2012, p. 4), extends “the learning spaces in the school” (Redman et al., 2013, p. 130), and liberates “the learner to realize [sic] enactment of anywhere, anytime” education (Brand & Kinash, 2010, p. 147). Heinrich (2012, p. 10) claims easier access to resources “without the cost and effort of joining and travelling to libraries, lectures and seminars” with concomitant efficacy. Souleles, Savva, Watters, Annesley and Bull (2015, p. 134) meanwhile cite Lee and Breitenberg’s assertion that proactive art and design students who worked “simultaneously with different media [...] and [processed] [...] diverse media such as text, images and sound” benefit most when time and space constraints, such as the physical studio, are removed.

This has two pedagogical implications. Firstly, teachers can give students texts,

quizzes, or videos, that introduce new material, to work through at home, then check student understanding and resolve misconceptions during class. Reichert (2016) construed this remediation as providing “differentiation in class” (p. 12). Cuban (1993) foreshadowed this as students receiving personal instruction without the teacher being present. This flipped classroom method enables students to view the material as many times as they need to, privately, without the need to indicate publically their lack of full understanding the first time, and it enables students to review the material as often as needed before being assessed on it. Johnson et al. (2016) reveal significant student gains with this blended teaching method. Student metacognition increases with awareness of differences in thinking between first and last viewings, which is an application of Kolb’s experiential learning theory (Healey & Jenkins, 2000). This is discussed more fully in Chapter 2: iPad Affordances and the DISA matrix.

Secondly, if teachers or students are absent, remote contact remains possible. Productive work continues during down time. Students submit completed work when they are finished, not when they next see the teacher. Reid and Ostashevski (2011) have remarked on the independence students quickly developed when iPads were used in this way. With Chohan (2012), they reflect on the reciprocity of students having more communication with, and support from, teachers when they are in digital contact with each other, while Meyer (2013, p. 266) notes “the presence of the iPad generally enhanced relationships between teachers and learners” (see also Faris & Selber, 2013; and Khoo, Merry, Nguyen, Bennett, & MacMillan, 2013). Time and place do not limit teachers or students as ubiquitous, mobile, flexible, and polysynchronous learning is a reality.

Polysynchronous classrooms relieve parents of worrying about children missing teaching and learning. The iPad is the device on which work is done, and through which work is submitted, assessed, and returned. Everything happens in one place, so students cannot leave things at home or school. Work is submitted directly to the teacher or returned to the student digitally, so it is not lost, misplaced, or goes unreturned. Students can repeat view videos of their teacher teaching, where a familiar person teaches them in a familiar way. The potential downside of poor teaching is remedied through access to the work of others, whether this be Khan Academy, Harvard University, or any member of the public who may choose to participate in making videos available online.

Digitised, enhanced learning compared to digital, transformed learning (C, D, E, G, H, I)

Secondly, the iPad changes pedagogy if tasks fulfil the modification and redefinition criteria of the SAMR model (Puentedura, 2014). This model distinguishes between enhanced learning (substitution and augmentation tasks) and transformed learning (modification and redefinition tasks), also known respectively as digitised and digital learning, where the difference lies in the degree of engagement with the technology. Students writing an essay will be discussed as an example.

Enhanced or digitised tasks

Enhanced or digitised tasks are categorised, firstly, as substitution tasks; they are paper-under-glass tasks such as writing an essay using a word processing app for typing rather than handwriting it. Technological engagement has not increased conceptual engagement. Thinking, not typing, is important. The iPad has improved student presentation, but not their thinking. Secondly, an augmentation task allows for the increased functionality of different fonts, but using the iPad in this way allows for word processing, rather than transformative engagement. In contrast, transformative or digital tasks require students to engage with the iPad in significantly different ways that extend the users' capability and allow them to do things that they could not do otherwise.

Transformative or digital tasks

Thirdly, for the essay to qualify as a modified task, the students could use the iPad to share their essays with each other digitally, perhaps by adding them to a class blog or wiki. This changes how the students think about their writing while they write, as they are aware of the need to write for a larger audience of their peers, who may well be far more critical than the teacher would be; and their work must be able to be integrated with that already submitted on the topic by the other students. If their writing is shared with audiences outside of school, it becomes more authentic as they share with those, often-expert adults, who have the same interests. This is borne out by Zielezinski (2016), who encourages student writing for authentic audiences. Deinhammer (2016) suggests learning from others around the world results in more nuanced understandings of cultural contexts beyond one's own. iPads can encourage "active teacher discourse communities" (Harris, Mishra, & Koehler, 2009, p. 406), as teachers share their work digitally with colleagues.

In the fourth place, using the iPad to create, film, and edit a video based on the essay, the task would receive a re-categorisation. Students would need to think about

their writing in much more visual terms, and the process would be geared towards a completely visual product.

These examples show students engaging with technology in substantially different ways that extend their capability through modifying the process and product of their thinking, as the pedagogy transformed the task, so it could only be completed digitally on the iPad. These tasks were not possible using one device alone before the introduction of iPads.

The payoff for parents is having digital access to their child's work, and to the shared work of the class. This is especially beneficial for reviewing a child's progress before or during teacher-parent meetings, even if viewed remotely (Redman et al., 2013). Parents can see their children working in ways that are familiar to them from their own working lives.

Student ownership of learning with teachers as facilitators (B, C, D, E, F, G, H, I)

Thirdly, pedagogy changes if students are given opportunities to take ownership of their learning in a more direct way than studying for tests and examinations allows. Oakley, Pegrum, Faulkner and Striepe (2012, p. 15) mention Gawelek, Spataro and Komarny's idea of "teachers and students...acting as 'co-learners and pioneers in the classroom'". Churchill, Fox, and King (2012, p. 252) affirm Beebe's inference that "iPads lead students to be more responsible for their learning". Clarke and Abbott (2016) inform on differentiated teaching amongst the young and less able students. Similarly, Redman et al. (2013) link the control of an iPad to control of learning, within a special school setting, while they, and Reed (2013), link student ownership of learning with higher creativity, where creativity is discussed later. This happens when teachers change from show and tell to facilitating the learning process by providing structures and formats for learners to find, integrate, apply, and present information by themselves. Reichert (2016, p. 16) formulates this in terms of students applying "the facts to which they have access", rather than "the teacher imparting facts"; the focus is on learning and not teaching, where Sackstein (2014) clearly expounds performance and competence pedagogic modalities. Students working independently, in groups, or as a class (Burden, Hopkins, Male, Martin, & Trala, 2012), epitomise a competence pedagogy, where students construct meaning through active engagement with the material, and learning increases while the teacher facilitates the context (Spark & Sackstein, 2014). Maher (2013, p. 60) notes that iPads and apps are "able to be used equally by the students and teachers, which

makes it a versatile tool”. Reichert (2016, p. 38) accentuates the capacity of multifunctional apps enabling “them to be integrated into multiple classrooms and disciplines”, in comparison with more limited and limiting task-specific apps. When students and teachers have equal access to resources through the iPad, they can be used for “powerful and collaboration and content generation” (Cochrane et al. 2013, p. 153). Johnson et al. (2016) explain this vanguard development as evidence of “the shift to deeper learning approaches that favour [sic] hands-on and student-centered [sic] experiences” (p. 6), leading to changes in tertiary education, such as “online learning, blended learning, and massive open online courses (MOOCs)” (p. 11), with “instructors...[as] flexible guides and coaches” (p. 14), able to “empower students to take ownership...and prime themselves for lifelong learning” (p. 28).

Teachers might progress sequentially through the four stages of the SAMR model, as they develop their TPACK, but are not necessarily required to (Geer et al. 2015). An earlier stage may be relevant even when teachers are more experienced in modifying and redefining their tasks. It is possible to see all four SAMR categories reflected in one task. If the teacher wants each student to research one aspect of the causes of World War I, and present this, the following might be revealed: substitution, where the teacher writes up the task requirements as a document in Pages; augmentation, where the teacher emails it to students; modification, where students find relevant information online, in text, image, or video format, and insert this into the individual Book Creator book that they compile; and redefinition, where all the students combine their individual books into one much larger Book Creator book, that is then shared digitally. The teacher has facilitated student ownership of their learning through giving detailed task information and rubric guidelines to them, then empowering students to find relevant information themselves, and finally, ensuring they integrate pertinent aspects as they apply their newly acquired knowledge in the required format of their final presentation.

Parents become aware of children working in more sophisticated, complex, and collaborative ways. Students are more willing to discuss schoolwork with parents (Burden et al. 2012), increasing the role of parents in their child’s education, and strengthening the school-home relationship (Redman et al., 2013). Students mature as they take more responsibility for what and how they are learning, which eventually has a positive impact when they enter tertiary education, more able to study independently.

Students as teachers of content and technology (A, C, D, E, F, G, H, I)

Fourth, this type of digital sharing can change pedagogy, as it has wider implications than students merely sharing their work with peers, as teachers have always required them to do. Clarke and Abbott (2016) consider students as teachers of their teachers, while Attard and Curry (2012, p. 79) designated students as peer teachers, quoting one research participant, “I am hoping that (the iPad) technology will get that idea across to them that hey, you can teach yourselves and guess what, you can use that to teach each other.” State of New South Wales (2012, p. 10) postulates “content-creation apps (with) more open ended design...foster higher levels of thinking and engagement, then apps with an instructive pedagogical design.” As mentioned above, if the teacher-facilitated but student-created Book Creator book becomes the class textbook or study guide for the topic, then students have become the teachers of their peers. In some instances, this might involve teaching about content directly, but also about technology indirectly; teaching the content and format of their presentation, as not all students will use technological affordances in the same pedagogic ways. Similarly, in talking about the early text editor Notepad for MS Windows, Laurillard et al., (2000, para 36) called attention to the reality that “the way it is used varies with context, and yet each way may constitute a productive learning activity. The affordance made possible by the Notepad is completed by the students’ interpretation and use of it.” If some of the student work is done at home, then students might also be responsible for teaching their friends, siblings, and even parents. Redman et al. (2013) expand this.

Teachers’ triple agendas of content elaboration, academic argument, and digital citizenship (D, E, F, G, I)

Fifth, teachers follow two agendas; that of content elaboration, and how it is realised academically. They discuss what proof or evidence reveals good thinking and acceptable argument academically through their subject. The iPad can change teachers’ pedagogy by allowing them to add a third agenda to their teaching, good digital citizenship, as the iPad enables teachers to develop and enrich their TPACK.

This has two aspects. Firstly, good digital citizenship is more than digital literacy, especially with regard to plagiarism and referencing, because of fingertip access to global digitised and digital resources in a range of different formats, as well as speed of access (see Oakley et al., 2012). Secondly, teachers may have had a DVD collection of speeches by world leaders. The iPad removes the necessity to store them. Now they can direct younger students to digital resources from a range they have pre-selected and

curated online, or older students to digital resources from the spectrum of opinion and thought within that subject. Although teachers are no longer knowledge gatekeepers, their responsibility now lies in teaching how to apply lessons on digital citizenship in and through their subject, also by using sources safely, ethically and appropriately themselves. Cut-and-paste plagiarism and using resources superficially hinder academic depth of argument. Teachers must set tasks that teach how to construct and support argument.

Parents, as well as wider society, profit from students who take digital citizenship seriously, as their intellectual honesty raises the levels of awareness around integrity, scepticism, and personal accountability.

Student creativity (A, B, C, D, E, G, H, I)

Sixth, easy and quick access to resources enables greater levels of student creativity resulting in more sophisticated products, even in the early childhood education classroom (Blackwell, 2014). “Teachers stressed...other benefits, such as the quality of presentations that they...or their students...could prepare, as well as greater student creativity” (Karsenti & Fievez, 2013, p. 26). Maher (2013, p. 60) frames multimodal resources as allowing “students to learn in different ways to achieve learning outcomes”. Students can use more media in more ways to create powerful pieces of work; pasting paper onto cardboard is no longer creative. Students can be given tasks that require a higher level of creativity, even in some cases, complete flexibility as to how the work should be formatted and presented. A student making a poster consisting of a printed picture of Hitler and some text from one of his speeches is not as powerful as searching for, selecting, and then inserting a video clip of the same speech into a Keynote presentation. If there are time-length or data-size limits to the task, students must make decisions about the relevance and appropriateness of different videos that previously would have been the responsibility of the teacher. In assessing how well an individual video meets the task criteria, students need to watch all the videos several times to justify their final selection, leading to greater familiarity with different aspects of the material, and a strengthened emotional connection of the material. Students who only read a textbook have a mere intellectual understanding of Hitler’s oratory. It is another matter to select one video from many to understand his oratory more viscerally, after seeing the intensity of his facial expressions, observing the forcefulness of his body language, hearing the tone and tenor of his speaking, and attending to the audience’s

response. Teachers will be well rewarded, perhaps to their initial surprise, in giving students some opportunity to increase the academic depth of their work on their own, and to have greater control over its creativity and presentation. Burden et al. (2012, p. 111) accentuate the interactivity of students and teachers learning together “through exploration and in collaborative dialogue...[with] both ...wanting to show each other...what they are discovering is possible with the device”. This goes some way to solving the problem of “the use of tablets for collaborative activities still (remaining) elusive for most teachers” (Sackstein, 2014, p. 123), as does Nguyen, Barton and Nguyen’s (2014) reminder that social apps can foster academics’ collaboration. Children can help their parents improve their own presentations or use their creativity to explore different hobbies or careers.

Conclusion

This researcher has argued that the iPad’s technological capabilities create technological affordances that can lead to the development of new pedagogical affordances, firstly, by tabulating specific examples of the concepts to clarify some relationships, and, secondly, by discussing the pedagogical affordances as six broad strands illustrating how teachers’ pedagogy can change. Each discussion lists specific benefits for teachers, students, and parents.

Teachers can use the technological affordances of iPads to transform their pedagogy and their students. Polysynchronous teaching and learning allows for education to happen face-to-face, synchronously, and asynchronously; for teachers to be present in more than one place at the same time; for students to repeatedly review material at their convenience; for increased student metacognition; and for students to submit work as soon as they have completed it. This ensures uninterrupted teaching and learning, as one-time, face-to-face teaching is no longer the norm, and parents know that teaching is always available for and accessible to their children. Digital, transformed learning alters the process and product for students, extending their capabilities, and bringing them closer to the world of work outside of school. When teachers focus on student learning rather than on the teaching of students, they allow students to own their learning. This extra responsibility matures students, enabling them to become independent, lifelong learners, where parents see their children working in more sophisticated, complex, and collaborative ways, working as adults do. Empowered students teach themselves, their peers, friends, and family members. Teachers who teach digital

citizenship develop their own TPCK, and raise levels of academic integrity in students and in wider society. Students who are good digital citizens and who are given opportunities to do work of their choosing, in formats of their choosing, develop confidence in their creativity and academic understandings.

There are clear relationships between the iPad's technological capabilities, its technological affordances, and the pedagogical affordances these allow. Teachers can use them to develop their TPCK, especially when viewed through the lens of the SAMR model. Moreover, there are six advantages for teachers, students, and parents when teachers incorporate these pedagogical affordances into their teaching. It is now appropriate to review the literature on affordance theory, as well as that on the affordance of iPads and the TPCK and SAMR models.

CHAPTER 2: LITERATURE REVIEW ON AFFORDANCES

Gibson's (1986) statement that "to perceive the world is to co-perceive oneself" (p. 141) sets the tone for any discussion on affordances. It is his basic premise that the affordance of X is perceived if X is perceived. While a succinct statement by Hammond (2010) encapsulates Gibson's concept of affordance as "the interaction between user and tool" (p. 211), the seminal discussion on affordances comes from Gibson, as cited in McGrenere & Ho (2000): "the *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill" (p. 127, emphasis in original). McGrenere and Ho (2000, p. 1) further list Gibson's three defining characteristics of affordances as being "relative to the action capabilities of a particular actor," "independent of the actor's ability to perceive it" (see also Gaver, 1991, p. 79, Kozma, 1994, p.13 and Laurillard et al., 2000, para. 5) and not changing as the needs and goals of the actor changes.

Hammond (2010, p. 216) broadens this by offering a further list of six of the properties of affordances as being part of the "real and symbolic properties of objects...the perception of a possibility of action...(that is further) shaped by past experience and context...(and) are discovered through direct perception, deduction, intuition, or signposting by others". Further, they are able to "precede internal mental ordering (have) both opportunities and constraints (and are) often sequential and nested in time".

While McGrenere and Ho (2000) cite Gibson as stating that affordances are both objective (independent of the actor) and subjective (when the actor acts on them), they note that Norman does not consider the perspective of the actor in his discussion: "the frame of reference for Gibson is the action capabilities of the actor, whereas for Norman it is the mental and perceptual capabilities of the actor" (p. 3). This issue of the differences between ideal, intended, and actual use is discussed later. They further discuss Gibson's view that affordances are extant or not, and while they relate to the actor's capabilities, they are outside of them and must signal their potentialities to an actor. On the other hand, they mention that Norman separates affordances into actual and perceived categories, with important aspects being the way in which their use is signalled as well as the potential for exploitation that the actor brings to the interaction; this latter is also related to the actor's sense of their ease of use. While Gibson focuses on

perception, Norman emphasizes design in order to make the perception of affordances obvious.

Gaver expands on this signalling point. It is our perception of, and interaction with, our environment that affords us “potentials for action” (Gaver, 1991, p. 79). Objects are easy to use when there is a match between their intended and actual use; Gaver characterizes this as a Perceptible Affordance, whereas a Hidden Affordance is the term he uses when an observer infers an affordance in the face of no perceptual information. He defines a False Affordance as arising “when information suggests a non-existent affordance so people mistakenly try to act” and a Correct Rejection as occurring when there is neither an affordance nor perceptual information about it (p. 81).

According to Gibson (1986) affordances imply “the complementarity of the animal and the environment” (p. 131). For McGrenere and Ho (2000), they can be thought of as the functionality an actor invokes from the objects in his environment, terming this “the actor-environment mutuality... (of an) inseparable pair” (p. 2). They further agree with Gaver that their usefulness exists independently of the actor, but their usability depends on his knowledge, experience and culture. I would extend this idea of usability to include his social identity and purpose; the former because of the learning it can engender, and the latter because purpose drives action. This will be expanded on in ‘The Role of an Actor’s Purpose’.

The Perception of Affordances

With regard to the perception of affordances, Gaver (1991) takes the stance that the understanding of affordances must include the nesting of simple affordances within more complex ones, with their consequent necessarily sequential revelation. It is his further contention that account must be taken of the actor's penchant for exploration, which is related to his purpose, and that this leads to the further clarification of affordances. Gaver argues that:

Exploration of afforded actions leads to discovery of the system, rather than knowledge of the system metaphor leading to expectations of its affordances. Learning is seen as a matter of attention rather than inference. The role of a good interface is to guide attention via well-designed groups of sequential and nested affordances. (Gaver, 1991, p. 82)

A distinction is drawn by Norman (1999) between the actual affordances of the computer, such as “its keyboard, display screen, pointing device and selection buttons

(which afford) pointing, touching, looking and clicking...” and its perceived affordances such as the icon or cursor as the “...affordance exists independently of what is visible in the screen” (p. 39). These graphic representations of perceived affordances are cultural conventions that he defines as “symbolic communication, one that works only if it follows a convention understood by the user” (p. 40). These conventions need to be learned (Oliver, 2005) and can be interchanged with other signs, symbols, or icons denoting the same thing.

A computer with a good graphic interface increases knowledge of computer icons which both helps the user to do new things and to discover new things to do. As a share button or icon, the arrow coming out of a square has become more universal than the two lines coming out of a dot icon, although knowing either makes it easier to interpret other signalled forms of the same affordance. A good interface will provide more alternatives for sharing than as an email attachment alone, including ones a new user might not have thought of, such as sharing to Notes or Photos on the user’s own device, or to social media platforms such as FaceBook, Twitter, WhatsApp, and the like. Hammond (2010) gives prominence to the idea that affordances entail both generative possibilities but also constraints.

Affordances and Constraints

Computer affordances can give rise to frustration, for example, if one operating system or device is not able to support as wide a range of affordances as another that the actor is familiar with. The interplay between software and the uses actors make of it, is discussed under ‘Mobile Computer Affordances’. The actor is constrained by the affordances of a particular device. Kennewell (2001) discusses Greeno’s idea that constraints “are the conditions and relationships amongst attributes which provide structure and guidance for the course of actions” and are closely related to affordances as they are “equally necessary for activity to take place” (p. 106). In short, affordances provide action through constraints that provide structure.

In designing affordances for electronic sharing, the programmer and graphic designer need to think like the non-specialist computer end-user to make usage more seamless and intuitive, as an actor’s purpose determines his actions.

The Role of an Actor’s Purpose

The idea of an actor’s purpose determining his or her actions is related to the paradigm shift in psychology away from behaviourism to interpretivism/humanism in the latter

part of the 20th century. For example, it was strongly argued by Heather (1976) in his critique of classical behaviourist psychology that the essential feature of people is that they operate with agency in their lives. As agents they are the cause of and are responsible for their actions. Such behaviour is active not passive, intentional not inertly responsive and unequivocally rooted in socially constructed and negotiated meaning that is communicated through language. Actors construct a world for themselves, then represent it to themselves and finally use it to frame their actions. Thus actors are aware of and live by social rules. Self-reflection enables actors to monitor the execution of their own and others' behaviour whether this behaviour conforms to, or transcends, the social rules. In essence, behaviour can be understood only within a framework of actions; an isolated action is incomprehensible apart from its social milieu. It is this that enables us to compare another's behaviour to our own. Shared meanings develop shared expectations and enable shared purposes.

It is the notion of purpose that can be described as overarching the concept of affordances as it determines both their usefulness and utility. It is an actor's purpose that leads him to explore objects in order to discover how they can be used to meet his needs. McGrenere and Ho (2000) contend that if their usability has been signalled clearly and obviously, through design-embedded information, then it is easy for an actor to use them in fit-for-purpose ways.

An object being fit-for-purpose is a wider notion than at first might be supposed. Of Gaver's four categories, it is the Hidden Affordance one that reveals the most creative, interesting, and unexpected actor-environment interactions. An actor is not limited solely to those affordances that have been designed and signalled. An object has an affordance if the actor can use it as such, whether or not it is immediately obvious. As Kozma (1994) declares, "the design itself does not emerge until the users interact with it" (p. 16), while Gaver frames it as "perceptual affordances are *inter-referential* ... what is perceived is what is acted upon" (Gaver, 1991, p. 81, emphasis in original).

These affordances often arise in 'Invention-as-the-Mother-of-Necessity' situations in which an actor has used successfully the affordances of objects for purposes that the designer could not have predicted. Apart from providing support when an actor sits, and from being able to be carried, moved around, or transported, a chair may also function as a one-step step-ladder, a barricade, a weapon, a restraint (if an actor is tied to it), a holder of great monetary or sentimental value (an Eames lounge chair or your great-grandfather's handmade stinkwood chair), as an artwork, or even as a piece of

firewood. Doubtless chairs have been put to other novel uses as well.

Digital Novel Use

This ability to put objects and their affordances to novel use is not limited to the physical world of objects, as it can apply in the digital world as well. Gaver (1991) contends, “the actual perception of affordances will of course be determined in part by the observer’s culture, social setting, experience and intentions” (p. 81). This is echoed in Kennewell’s (2001) paraphrase of Squires and McDougall’s assertion “that some of the most innovative educational activities occur when teachers and students actually subvert the designer’s intentions, and these interactions are necessarily complex in nature” (p. 104).

As an example of a novel or subverted use, the researcher was privy to a conversation between two colleagues in June 2016. This conversation became one of the revelatory moments that led me to undertake this study. ETC3 showed the isiZulu teacher how a randomizer app for decision-making, the Decide Now! app, could be used to teach vocabulary to her Grade 5 class. The app is designed to “help you to quickly choose your next step in different situations... (and it) allows you to choose among your OWN creative ideas too! Share your decisions with your friends” (Catforce Studio, Decide Now! emphasis in original). These are general Barnum-type statements, and are not specific predictions about how to use the app creatively. ETC3 saw a hidden affordance in the app and showed the teacher how to exploit it for the teaching of new vocabulary words by putting the words into the segments of the app’s spinning wheel. When it came time for the class to learn their vocabulary, rather than group members taking turns to choose a new word for the next girl to spell, which they thought might be unfair, they decided spontaneously to let the Decide Now! app randomly choose a word for the next girl to spell out aloud to the group. This meant that every girl now had an equal chance of getting an easy or difficult word to spell, group conflict was avoided, harmony was maintained, and the girls focused on increasing their vocabulary. They extended one hidden affordance with a further one. The app designers could not possibly have imagined these affordances during their design and trailing process, but the actors did. They used a new medium in an old way.

Media and Method

It might seem as though the ETC3, the isiZulu teacher, and her students used digital media to learn in a new way and so fulfilled Kozma’s (1994) hope that media would

influence learning. However, this idea is completely dismantled by the application of Clark's (1994) "*replaceability test*" (p. 22, emphasis in original). This test posits that if the same results could be obtained through the use of another media presentation, then the learning must be attributed to the instructional method or strategy, and not the type of medium. In this instance, the app could be replaced by the new vocabulary words being written on flash cards, with one student randomly choosing a flash card from a facedown selection, a second student pronouncing the word for a third to spell it out aloud. The same benefits would accrue and the flash cards would have the extra status of aligning with Clark's (1994) directive that "we must always choose the *less expensive* way to achieve a learning goal" (p. 22, emphasis in original). Clark (1994) further rebuts McLuhan's conflation of media and method, and the suggestion that some methods are intrinsic to some media, with the view that media can be applied to other uses than those with which they are traditionally associated. He pithily answers Kozma and McLuhan thus: "all methods required for learning can be delivered by a variety of media and media attributes" (Clark, 1994, p. 26). Method not medium, pedagogy not technology, affords learning.

Joy and Garcia (2000) bolster Clark's assertion with their review of the impact of computer technology as a delivery medium in education. They conclude firstly, that designers of asynchronous learning networks (ALNs) "should not assume that one delivery medium is as effective as another" (p. 34); secondly, that validity problems and design flaws negate findings that computers improve learning; and thirdly, that many findings are not generalizable outside of the research laboratory. If the affordances of computers in education were as great as hoped for, then ALNs in particular would trump standard pedagogical practices thus enabling students using them to outperform all others, but they do not. This fact is testament to the vital importance of teachers using sound and time-honoured teaching practices. Moreover, Kennewell (2001) highlights the role of the teacher's knowledge of pedagogy, as well as his ability to integrate and apply ICT in his classroom. He notes, "to achieve the task outcomes, students use their existing abilities, together with supporting features of the setting" (p. 105). He further explains that teachers need to plan these affordances to help students overcome the disparity of their knowledge as compared to that which the teacher wants them to hold, in other words, teachers need to help students work in their zone of proximal development.

These setting features are expanded on by Laurillard et al. (2000) as the criteria for

designing multimedia for learning. They start from the primacy of the narrative structure and contend that text that is not clearly structured is difficult to navigate and thwarts students' cognition. However, well-structured text, per se, is a necessary, but not sufficient, condition for understanding. Importantly, students must understand the structure of any individual piece of text to read with fluency and comprehension (Silburn, 1991). Laurillard et al. (2000) extend the discussion of affordances by seeing their usability in terms of operational thinking, as being part of Taylor's category of "'task syntax', that is the aspects of the interface which students operate in order to address the task" (para. 29). They list the "design features (that) can be built in to act as affordances (as)...Goal...Sub-goals...Menu...Resources...Interactive activities... (and) Model answer" (para. 46). Of course, the student is not passive in his own learning and filters everything in constructing his own narrative understanding. This development is also part of the student's wider educational setting, as is the classroom.

Isolated or Integrated Medium Influence

The classroom is part of the wider educational setting. Kozma (1994) cites Salomon's contention that "each event, component, or action in the classroom has the potential of affecting the classroom as a whole" (p. 15). Kennewell (2001) regards the influence of ICT in the classroom more strongly: "variables concerning the teacher, students, classroom organization, resources, subject/classroom culture and norms (rules, routines and expectations) will influence what and how students learn. ICT will not act independently of these." (2001, p. 102). The context of ICT use is crucial as "even when a seemingly identical lesson is planned, the variations in the setting lead to different forms of activity, different learning outcomes, and a different effect of ICT" (Kennewell, 2001, p. 112). With this in mind the discussion now turns to the unique affordances ICT might offer in the classroom.

Unique Affordances

I would strongly disagree with Kozma's (1994) opinion that "the image of students working one-on-one with a computer in isolation from other students, or even a teacher, evokes memories of the teaching machine and the Skinner box ..." (p. 16). The researcher would argue that the very opposite is true as it is the affordances of modern (post-Kozma) computers that raise the images of pervasive student collaboration. The degree of collaboration afforded by Web 2.0 (and later) technologies enables students to co-write documents asynchronously or in real time, whether or not face-to-face teaching is

happening or a teacher is even present. This is discussed later under the heading ‘Variable Uptake Amongst Teachers’.

Almost as an aside, it is worth noting that some tablet users informally report finding a touch screen easier to use than a laptop or desktop computer, as the barriers of the mouse and track pad have been removed. This aligns with McGrenere and Ho’s (2000) claim that “an affordance is easier to undertake when the time to perform that action is reduced” (p. 7). Why then has there been variable uptake amongst teachers if they have access to computers and if the affordances of this technology are easy to undertake?

Variable Uptake amongst Teachers

Many teachers, not only older or more experienced ones, have been slow to use computers in their teaching. In the researcher’s experience it has not been the case that younger staff members automatically transfer their private use of technology into a pedagogical usage in their teaching. Krauskopf, Zahn and Hesse (2012) concur that “teachers as professional users of technology would need to act based on their professional knowledge, not just on early computer use in their past” (p. 1 205). Conole and Dyke (2004) cite Britain and Liber’s conclusion that slow uptake results from a “lack of a coherent framework within which to evaluate both the pedagogical benefits and the organizational changes required to effectively implement it” (p. 113). Of these two reasons, the researcher is aware that the latter is of more import to teachers as both organisations and people change slowly and with difficulty, and teachers are far more concerned with pragmatic rather than theoretical improvements to their teaching. There is a third leg to this uptake stool – the teacher. In informal staffroom conversation teachers express their fears about “lacking specific (pedagogical) knowledge” (Krauskoff, Zahn and Hesse, 2012, p. 1203), not knowing how to integrate computer usage in their lessons, not knowing what they don’t know, or of looking incompetent in front of their students. This is particularly the case where there is no ed tech coach to teach and to role model successful computer integration to teachers. There is also the problem of the disconnect between the ideal, intended, and actual use of computers by teachers. They need to revise their mental model about what they and their students can do with the technology (Johnson-Laird, 2013). Further, in most cases, especially in the senior classes of high school, where the final matriculation examinations underpin and overshadow all activities, teachers are bound by the tyranny of the timetable, chained to the curriculum,

and often disappointed by stand-alone staff development workshops. Those who do use computers in their teaching, often limit the devices' affordances to email, word processing, simplistic searches for information and slide show presentations. Those who do more with computers in their teaching, usually confine this online foray to one or two topics, apps, or affordances each year.

One of the most obvious affordances of using a computer and the Internet is the unparalleled access to information that it provides. Some view the Internet as a sand dune of knowledge; a shapeless, shifting and slippery slide into sound bite knowledge. However, in education, the debate is no longer about access to information, but about how to search for and then filter that information for that which is relevant and appropriate. Search results that end in superficialities tell more about the questions being researched and an individual's search capabilities than about the depth and breadth of information that it is possible to find. Teachers need to frame questions that encourage deep research and explicitly teach research skills to their students. This is particularly important in an online environment to prevent students adding hyperlinks as a modern version of cut-and-paste to their document. They need to engage with the ideas in the text before consolidating them into their own writing. Practised research skills can lead to information that is an inch wide and a mile deep, rather than the other way around.

This highlights rights of access to scholarly knowledge and institutional information. Not everything is in the digital and online arena. Those academic disciplines that outsourced editing, peer review and publishing to third party publishers, ceded control of their material to the same, with the result that access is only available through paid membership or subscription. Open access publishing seeks to redress this. In the same vein, some publishers have moved from 'pay to access' to 'pay to publish', but this has seen the rise of online pirate journals that charge to publish according to open access principles, but entirely neglect any form of peer review, the very bedrock of academia.

However, it is less about access and more about appropriacy. In their taxonomy of ICT affordances, under the heading of *Accessibility*, Conole and Dyke (2004) call for "a change in the users' learning and information analysing skills" (p. 116). Students need to be taught how to search effectively for relevant information and how to evaluate websites. While students work in a more sophisticated digital environment now, they are not the digital natives Prensky (2001) first claimed them to be, as their social media use does not render them conversant with academic conventions, without the calculated

intervention of a teacher. The same applies to teachers; this intervention for teachers should be the main role of the ed tech coach.

In their discussion around the *Speed of change*, Conole and Dyke (2004) are quite correct to be concerned with “issues about quality, lack of authority of sources and lack of reflection...(and) the speed of (informational) change...(that) is a challenge for the educational use of the new technologies” (p. 116). While I agree that there is less depth of analysis when the sound bite is the unit of description, and that students do need to learn efficient search techniques, I would disagree to some extent about the level of the challenge. At high school, much of the information that teachers present is well researched, understood, and contextualized; it is not at the cutting edge of new intellectual developments, which are not always immediately relatable to school curricula. The causes of the 2008 financial crash might have figured in a 2010 Accountancy or Economic Management Science project, but they have not fundamentally altered early stage financial teaching in any substantial way. High school students are not as exposed as university students are to rapidly changing information, as they are still learning the basics of different disciplines, but exposure to other opinions is still of critical intellectual benefit.

“Exposure to the experience of others is a key ingredient to effective learning and a potential affordance of ICT” (Conole & Dyke, 2004, p. 117). This form of diversity is particularly true of exposure to narrative writing, but weight must be given to the idea that people do not always change for the better as a result of being exposed to the experience, views or opinions of others. It is more likely that they will look for confirmation of their own worldview, with its idiosyncrasies, biases and stereotypes, in an online environment. Teachers are not immune to this; it is how they use online information that will challenge or confirm their own and their students’ worldviews. Teachers also need to make responsible digital citizenship explicit in their everyday lessons, as younger students face the allure of immersion in the digital world to the extent that their social skills and general personal development could be stunted, and an indiscriminate digital presence holds more dangers than Facebook fatigue or Instagram envy.

While they are never uniform in any population, communication and collaboration is tied to the e-literacy levels of staff and students (Conole & Dyke, 2004). Meaningful learning can take place if the usability or task syntax or “the mechanics involved in using ICT does not distract students from the intended learning goals” (Foo, Ho &

Hedberg, 2005, para. 22), especially if teachers are willing to learn from their students. Even if a teacher knows a particular programme or app exceptionally well and feels there is nothing more he or she could learn about it, students could still be excited to point out new affordances to other students and teachers.

When all parties have a reasonable level of expertise, then it is easier to focus on the requirements of the task itself, its usability or “task semantics” (Taylor as cited in Laurillard et al., 2000, para 29). Foo, Ho and Hedberg (2005) delineate these generative task activities as being on the higher end of a continuum that has presentation task activities as its lower end, as “knowledge generative activities...produce shared understandings – there is co-construction of knowledge between the teacher, the student and others and learning occurs as the result of interactions among (them)” (para. 7). In focusing on the task itself, myriad opportunities open up for teachers to give students appropriate and real audiences to write for, whether this audience is comprised of classmates, students in other schools or countries, or even external organisations. If this collaboration takes place asynchronously, then students have more time to think, write and edit, particularly if they can “access and build on archived material available from earlier discussions” (Conole & Dyke, 2004 p. 118). In light of their discussion on the multimodal and non-linearity aspects of the digital world, it becomes particularly important for students to have easy access to earlier iterations of their work, and that of their peers. They also need to be confident navigators of the digital world, where usage reveals structure. If students have a need to find something out, then they will be pragmatic in doing so, either finding their own way or asking for help; this is often the opposite of what happens in school teaching. It is almost axiomatic that website usage can lead to unintended consequences. Conole and Dyke (2004) highlight Giddens’ observation that “the technologies have not necessarily been taken up or used in the ways originally intended... (and there is) an intrinsic level of fragility... (with) abuses, viruses, SPAM, or simply the servers ‘being down’...and a need for immediacy... (that) can result in levels of dependence” (p. 119). Teachers and students need to be alerted to the fact that they must always have an offline Plan B in case a website has been taken down, or the Wi-Fi goes down, or it takes too long for 30 students to log on at the same time, or personal devices have not been charged, or have been left at home, and so on. Their discussion on *Immediacy* with respect to response times for online requests and the expectation to be available 24/7, can also precipitate in teachers a need to be needed 24/7, not unlike the psychological effect a continual adrenaline rush of working in a hospital

trauma unit might have on emergency room health professionals.

It is in their discussion of *Monopolization* that Conole and Dyke (2004) raise the matter of interoperability. There are pros and cons in the debate which focuses on the relative affordances of using iOS (iPhone Operating System), or Android, or web-based/platform agnostic systems. Clearly this relates most pertinently to the infrastructure a school is able to supply and support. School-based digital surveillance of the sites teachers and students visit also has positives and negatives. Geotagging or location indicators can present fascinating opportunities for real-world interactions, as Pokémon Go has recently shown, but this must be part of detailed teaching around responsible digital citizenship, as potential employers, and others, might have variable access to one's digital footprint in the future. In turn this could lead to negative consequences or outcomes for the student.

Developing a Digital Teaching Footprint

Effective ed tech coaches stand at the centre of the praxis/theory debate, as teachers do not work as academics do, and academics do not work as teachers do. An ed tech coach should have an understanding of the relevant theory and also have experience in good classroom ICT integration. "Clearly, there is nothing inherent about ICT that nurtures reflection-the key is how it is used...The challenge, as Laurillard et al. (2000) note, is how we can use ICT to transform information" (Conole & Dyke, 2004, p. 118). The primary role of an ed tech coach is to help teachers do this. Krauskopf, Zahn and Hesse (2012) stress that teachers need to develop mental models that accommodate both the technical aspects of the technology and, importantly, its pedagogical aspects in order to deliver content that they find difficult to teach or that students find difficult to learn. The most efficacious way to achieve this is with the help of an ed tech coach.

Angeli and Valanides (2005) highlight a problem that entangles many teachers, that of planning lessons around activities not objectives, where the lesson is driven by technology not pedagogy. This is an important consideration for developmental activities that should lie in the zone of proximal development. For example, the ability to make, edit and show a movie on a digital device can become the focal point of a lesson, instead of the content of lesson with its concomitant need to develop and structure conceptual relationships. Cox et al. (2003) foreground this relationship between activity and objective: "Specific uses of ICT have a positive effect on pupils' learning where the use is closely related to learning objectives" (p. 3). Krauskopf, Zahn and Hesse

(2012) evoke Salomon's conclusion that "students...connect the use of video with investing less mental effort in processing the content" (p. 1 203). In watching videos students need adequate preparation beforehand, as they comment that a teacher's intended use of the affordances of YouTube is hampered by the already established mental models of movies as entertainment in the classroom. When students make movies in class, the teacher must ensure that the students write their scripts, then storyboard their camera angles and transitions and finally check that their video answers the question they have been asked. As always, it is working with information, through reading and writing that builds intellect and learning. The various affordances of computers could make this easier to develop.

Affordances to Build Intellect and Learning

Using technology to build intellect and learning is not using it to deliver content as much as it is using it "as 'mindtools' to support meaning-making by students" (Jonassen quoted in Foo, Ho and Hedberg, 2005, para. 7, emphasis in original). As discussed earlier, this is using ICT to generate, rather than to present, learning. When students have supportive teachers, access to information and activities which allow them to use ICT generatively, then the concomitant "engaged learning...(is) learner- centred and learner-directed" (para. 9) They quote Jones et al, as stating that this leads to more student interaction, teacher-student collaboration, inter-school connections and teacher-as-facilitator involvement. In particular they note, "(teacher support in the form of modelling) in the online forum resulted in students asking more higher-order questions" (para. 20). Further, students who "processed their thoughts more slowly... (responded in an engaged manner when) in front of a computer" (para. 21). Lastly, they reported on a teacher who used "'open-ended' IT resources... (for) a learning task that afforded multiple perspectives and solutions...and used open-ended questions to guide student discussions" (para. 27, emphasis in original). This effectiveness derives from making "explicit the cognitive processes involved in using the tool and (in involving) students in the cognitive process" (para. 30), rather than assuming they would know how to use the features of the tool. In all, richer and more in-depth learning is the result, with students taking ownership of their learning progress with there being little room for lecturing and none for spoon-feeding. In summary, "Actual (ICT) uptake depends largely on teachers' skills and capabilities" (Angeli and Valanides, 2005, p. 292).

Affordances and Teachers

At its nucleus, ICT affordances centre on what teachers believe learning to be. If they see it as a cognitive endeavour in which information from various sources is socially structured into complex relationships to reveal these same, then there are many affordances that ICT can bring to the classroom. Teachers can use ICT affordances to help students to grapple with information, through both reading and writing, to transform it into their own knowledge. Foo, Ho and Hedberg (2005) affirm that “The teachers’ understanding of what constitutes effective learning and their roles in students’ learning also determine how ICT is used” (para. 35). Good teachers will reflect on their practice to progressively refine it, but need explicit help in integrating ICT tools and pedagogy (Angeli & Valanides, 2005). Cox et al. (2003) underline this: “Insufficient understanding of the scope of an ICT resource leads to inappropriate or superficial uses in the curriculum” (p. 4). While an ed tech coach could provide this integration and understanding, it also might be sparked through the examples of colleagues.

A colleague at another school forwarded an email from a high school librarian at the International School of London in Qatar, who shared a conversation she had with a lecturer in Doha who teaches Arabic translation at university level through Wikipedia:

Students translate articles from the English Wikipedia and upload them into the Arabic site, and then see what edits and comments are posted. It serves a double function of giving the students practice but also expanding the Arabic site. They also have to learn to attribute the original correctly, and sometimes follow the links and give a summary in Arabic as well as linking to the original in English. (A. van Zyl, personal communication, November, 13, 2015)

This example meets seven criteria the researcher regards as being important for using ICT affordances in ways that reveal good ICT pedagogy: pedagogically not technologically driven teaching, reflective practice, transformative teaching, generative activity, contextual relevance or situatedness, appropriate and in-depth ICT resource use. It also exemplifies the point Valanides makes that ICT should not be “considered a mere presentation or delivery medium but a powerful cognitive tool” (Angeli & Valanides, 2005, p.298). Moreover, knowing only what the Doha Arabic lecturer does could be enough to inspire South African language teachers to transform their own practice in a similar way, or at the least encourage them to reconsider their own teaching practices.

The example also meets many of Puentedura’s (2014) SAMR model definitions that outline the general stages most teachers progress through as they integrate ICT into

their teaching. The Doha lecturer had moved his teaching activity through all four stages of the SAMR model: he had done more than substitute paper translation with electronic translation; the task had been augmented through the use of the attributions of, and links to, the original website; the finished translation had been modified by being uploaded to an international website; and the task had been redefined through students contributing to the Arabic site and by having to respond to edits and comments made by the Wikipedia staff.

The Affordances of iPads

In the same way that digital books led to a reappraisal of printed books and the role of text generally, Oliver (2005) makes the invaluable point that “studying technology illustrates issues about education more widely” (p. 411). Whether one subscribes to the integrative TPCK model of Mishra and Koehler (2006), or to Angeli and Valanides’ (2013) generative TPCK model, or to Puentedura’s (2014) SAMR model, it must be understood that the teacher’s approach to teaching with or through technology is the heart of successful ICT pedagogy. “What a teacher does with *it* is more important than what the *it* is” (S. Rockman, as cited in Cuban, 1993, p. 191, emphasis in original, see also Cox et al. (2003) and Darling-Hammond, 2006). The teacher’s pedagogy will determine the approach to the affordances that are pertinent to iPads. Now the discussion will focus on five different areas: Positive Aspects of iPad Usage, Negative Aspects of iPad Usage; Aspects of iPad Usage by Teachers; iPad Affordances and Ed Tech Coaches; and iPad Affordances and the DISA matrix.

Positive Aspects of iPad Usage

Since the release of iPad 1s to the market on 3rd April 2010, research into their educational efficacy has both increased and diversified. Apart from the size and portability of the iPad, one of the first things users noticed is the “basic affordance of the...touch-based manipulability” of the touch sensitive screen because of our intuitive knowledge using fingers “to manipulate things...in a tactile, self-explanatory manner” (Golland, 2011, p. 9, 10). Even those who have used only a desktop or laptop computer previously, informal observation seems to bear witness to their adapting quickly to using a touch screen rather than a mouse or track pad.

One of the most important affordances of an iPad was noted in the very early research of Brand and Kinash (2010) who stated that “mobile devices...liberate the learner to realise enactment of anywhere, anytime” (p. 147). State of New South Wales

(2012) portrayed this as “a shift away from the industrial era model where the classroom is the central place of learning driven by the teacher and limited to instruction within the school day” (p. 4). In the classroom, when an iPad does not need to be physically tethered to either a power source or a network cable, both teacher and student are free to work in a flexible and unrestrained way as the teacher is not a fixture in the front and the students have no need of stipulated seating. This is comparable to the idea mentioned by one student that “I can also walk around the room with my iPad. It feels like one step closer to the idea that technology doesn’t have to be this external thing” (Alyahya and Gall, 2012, p. 1 269). While all these researchers worked in a tertiary environment using iPad 1s, they concluded “...educators can connect with and encourage learners to use multiple means of inquiry and...teachers (can be encouraged) to use multiple forms of presentation” (Brand & Kinash, 2010, p. 150). The capability of later iPads, in which the camera gives photo and video possibilities, takes multiple forms of inquiry and presentation to another level.

Bansavich (2011) also looked at the potential an iPad might bring to tertiary education. As iPads had been commercially released in the previous month and were not widely disseminated yet, and the University of San Francisco (USF) participants wanted professional development (PD) to be linked to collaboration across disciplines, Technological Content Knowledge (TCK) capacity was built in the faculty first. As later anecdotal evidence in other educational contexts would testify, this is the best way to introduce this new technology; schools who let staff use the iPad for six months as a personal device before they attempted to teach with it tell of higher levels of engagement by those teachers. Those lecturers selected for the USF study were well-established staff experienced in using technology in their teaching. An expectation to contribute to the iPad study wiki led staff to use the Discussion tab “to communicate with other cohort members outside of the scheduled meeting times” (p. 6). Further, this asynchronous communication was made easier and quicker on the iPad as it is a portable device as mobile as a laptop, but smaller, lighter, and less cumbersome. Alyahya and Gall (2012) elaborated that iPads made it easier for graduate students to “work continuously...and to work in between doing other things, which ultimately saved time” (p. 1 270). In effect, they were able to use what might be termed ‘lost time’ productively, as they always had their work with them in an easy to access format, whether it was searching for and reading articles, taking and organizing notes, writing papers, or using the organizational tools to structure their time and plan their academic

work. Cochrane, Narayan and Oldfield (2013, p. 152) termed this “flexible access to course materials and communication tools beyond the classroom”.

Bansavich (2011, p. 6-7) noted that participants found various affordances when using iPads. It is possible to group these into three categories. The first centered on the physical and technical properties of the iPad: design; interactive touch screen; long battery life; processing speed and ease of use. The second category concerned apps such as GoodReader and Dropbox that supported the opening of various file formats and the accessing of documents on different types of computers and platforms. The last category concerned how the participants used the iPad. They commented on its usefulness: as an e-Reader and electronic textbook; for annotations and note taking (including font size, zooming, and highlighting – see Alyahya and Gall, 2012); for viewing multimedia presentations; as an interactive device for teacher-student and student-student relationships and for mobile learning inside and outside the classroom.

Watlington (as cited in Reid & Ostashewski, 2011) highlighted the affordances of “interactions...(which) are more visually presented than on smaller smart phones...(on) a light robust textbook-sized screen” (p. 1 689) using a range of light finger touches (such as taps, swipes, pinch-zooms). Ostashewski, Reid & Ostashewski (cited in Reid & Ostashewski, 2011, p. 1690) considered that the “audio recording tool, GPS capabilities, and integrated speaker system make the device usable as both an information gathering and as a small group display device. The multimedia capability together with the iTunes multimedia database makes this device a customizable media library.”

Gawelek, Spataro and Komarny (cited in Reid & Ostashewski, 2011) took this multimedia capability further. They reported on iPads being used for “real time backchannel discussions during class time, (and) as clicker devices” (p. 1 690). Backchannel discussions projected onto a whiteboard (or later through Apple TV onto a screen) in the classroom provided peer support, prevented the students from having to work in lock step, and freed the teacher to attend to others needing individual help without interruption. Golland (2011) concurred: “Teachers got to do more personal work with fewer students” (p. 38). This will be expanded on later.

Murray and Olcese (2011) began their discussion on teaching and learning with iPads so: “With the introduction of the iPad, Apple has succeeded in establishing a new form and input/output factor in the personal computer arena” (p. 42). They then consider “whether or not the iPad and its software environment allow users to do things in educational settings that they could not otherwise do” (p. 43). This could be termed as an

extended capability. It is in special needs education that these points are most many dramatically exhibited:

The class also had a special needs student who was basically non-verbal. The teacher found the functionality of some apps provided the child with learning experiences beyond what was previously available in the class. Apps like Speak It! allowed her to present information and ask questions in class. The teacher was also very insistent in noting for the researchers that the iPad and its apps were more useful to this special needs child's education than the thousands of dollars of specialized equipment already provided to the student. The iPad and the inexpensive apps were thousands of dollars less expensive, and more readily customizable for this student. (Reid & Ostashevski, 2011, p. 1691)

For many teachers, an important iPad affordance is encapsulated in this teacher's words, "I don't have to be the guru of technology, my students will be. And they have proved it over and over again" (Reid & Ostashevski, 2011 p. 1692, also Oakley et al., 2012). Teachers who are willing to learn from their students empower both parties.

In considering the educational uses of iPad apps, Murray and Olcese (2011) added consumption/collaboration to Means' 1994 categories of educational technologies used as, or to, "tutor, explore, tool and communicate" (to see if the software) "supports a key 21st century skill-the idea that knowledge is socially constructed and negotiated" (p. 43, see also Meyer, 2013, p. 260). Their list of affordances included: multi-touch surface to type on a virtual keyboard or play multiple keys (and hear multiple notes) on a piano application; an accelerometer for screen rotation, and to measure distance and speed; peer-to-peer sharing over Bluetooth with headphones, microphones and keyboards; 3G cellular capability for Wi-Fi; a built-in microphone and a built-in speaker. Golland (2011, p. 32) notes that it is difficult for a user to hear through the speakers built-in to the iPad if the class is noisy but headphones would circumvent this.

Murray and Olcese (2011) list these affordances as being in addition to those arising from the apps that Apple installs in their operating system during manufacturing:

an e-mail application, a web browser, a photo management tool, a tool to view videos on the device, access to YouTube, the ability to manage and listen to audio from iTunes, a maps program, notes programs, a calendar, the ability to search across applications, and some accessibility items. An eReader in the form of iBooks is also included. (p. 45)

Although they considered that there were few innovative apps then available, they did give an example of one: "ABC Phonics functions very much like traditional flash cards with the added benefit of having audio and phonetic representations of

words to be learned” (Murray and Olcese, 2011, p. 46). They also referred to

functions that provide users with advanced paths to interaction...via Bluetooth...social networking sites...(and) cloud computing services...where data can be navigated across multiple devices, shared with multiple users and access resources like email and various file formats from various locations and devices with few constraints. (p. 46)

With regard to extending capability, Murray and Olcese (2011) discussed in detail apps such as Leaf Trombone and Ocarina (for musical performance on a virtual stage), Star Walk (for astronomy either from your point of reference or from another of your choice), Shakespeare in Bits (Shakespearean plays which incorporate the text, a dictionary and animated video enactments), Sundry Notes (which affords the typing, drawing, audio and video recording, and picture insertion of notes that can be emailed or posted to social media), OmniGraph Sketcher (for data graphing), and G (for gravity simulations) (p. 47).

Golland (2011, p. 30) listed a number of iPad affordances. He considered that its technical capabilities allowed for easier switching between different apps, for example, when reading a Portable Document Format (PDF) and then taking notes digitally. In essence this permitted activities to be completed more quickly with an iPad than with pen and paper, so this both allowed more time to learn new things and saved on printing costs, especially that of paper and ink. Its audio-visual specifications enabled students to re-watch videos (p. 31), so that material could be accessed more than once possibly making it easier for students to learn through repeating viewing of the material. These integrated functions give the iPad a multipurpose ability. As a paperless device it can be used as a notepad that also has a questionnaire function, a presentation tool, a research tool and it can be used to read books. It can be used for the easy distribution of level-appropriate reading material (p. 31). This is especially important for the dignity of reluctant readers who do not want others to see that they read easier material or that they read more slowly than their peers. Golland also raised some of the benefits for teachers. If class-held iPads, rather than individually owned ones, are synced before the lesson then the app could be physically sited next to its extra activities to eliminate distractions and encourage on-task learning (p. 33). Teachers can use apps to customize instruction, such as allowing students to voice-record annotations to a slideshow or picture story (p. 38). If two students each have an iPad they can search on one and type on the other, allowing for simultaneous collaboration and involvement from both parties. Students could use it as a translation device and might find it easier to make

word/picture associations.

One of the strengths of an iPad, mentioned by Alyahya and Gall (2012), is the choice students are given to write using the iOS Pages app or through the Microsoft Word app, something not achievable with Android devices as they do not allow for iOS apps to be downloaded so there is no reciprocity. Further, they elaborated (pp. 1 268-1269) on how iPad affordances have positively impacted the students' academic lives. One student commented: "It's really an all-in-one device with...Internet...to-do lists(s)...audio recordings...music and pictures...notes...I have everything in the same place...planner, articles, notes, emails, appointments." Another reported: "I can highlight the main ideas with a different color, save them in a summary and then email them directly to me." A third declared: "I can read in the dark. It's nice to not have the lights on when I am studying and other people are sleeping." Generally the researchers disclosed that the iPad afforded students opportunities to add pictures from the Internet as well as photos taken with the device's camera, sometimes of the lecturer's board notes on the board, to notes they had made either using the keyboard or a stylus. This speaks to the high level of multi-functionality that can be exploited.

Improved "computer literacy skills... (and) quality of pedagogical support", as well as "a wider range of teaching strategies", are mentioned as benefits for students by Karsenti and Fievez (2013, p. 6). Student-centered pedagogy, or heutagogy, is at the kernel of Cochrane, Narayan and Oldfield's (2013) work on the pedagogical use of iPads as they consider the device to be "a catalyst for pedagogical change" (p. 146). While Meyer (2013) acknowledged the cost savings connected with iPads as requiring "less maintenance than other technologies... (they also make) technology more accessible to students, (and) allow schools to be more inclusive of different learners and learners' needs" (p. 261), he is concerned to frame the iPad-as-change-agent debate in terms of the specific contexts in which iPads are used and how they contribute to learning. He revealed a more student-centered pedagogy in articulating flexibility is its greatest affordance as students integrate iPads with their other resources and technologies, in ways which are personally appropriate and relevant to themselves.

Participants favourably distinguished iPads from laptops through the "quick start-up, the mobility of the device and the integration of a range of peripheral technologies" (still and video camera, Internet access and voice recorder) (p. 7) in the research undertaken by State of New South Wales (2012). These affordances helped the students to share their work digitally. They also shaped the teachers' pedagogy by

increasing their ability “to provide on-going, just-in-time feedback and also (the collection of) cumulative assessment data” (p. 7). She anchored her argument on the educational application of iPads; “As the iPad is an intuitive device, the emphasis needs to be on pedagogical approaches and task design, rather than on the technical aspects of using the device” (p. 8). In other words, teachers could teach with, or through, the iPad, and not about it. She sees it as “an educational tool that can support learning...if accompanied by student-centered pedagogies and authentic learning experiences” but teachers need “explicit training...on the best ways to implement iPads in their area of expertise as there is great variation in (implementation)” (p. 9).

One new student-centered form of pedagogy that Apple TV can afford is its ability to display active collaboration between students. This is an extrapolation of Schmid’s (as cited in Agostini and Di Biase, 2012, p. 47) finding on multi-touch IWBs that when “children could interact with the digital content simultaneously... (they talked) more about the task... (which supported) better collaboration”. This resulted from group members interacting when they wanted to rather than when they were directed to by the teacher. Further, “their discussions involved explicit reasoning and justifications, while they can work in a parallel way on the same task.” He concludes “that children are more motivated in lessons because of the high level of interaction and discussion”. Agostini and Di Biase (2012) see the display of this shared active collaboration as representing “a shared score, facilitating discussion and mediation among all pupils, supported by (the) teacher” (p. 50). Cochrane, Narayan and Oldfield (2013) concluded that “while initially designed and presented as a web enabled content delivery device the iPad iOS ecosystem has developed into a powerful collaboration and content generation platform” (p. 153). These are cogent ripostes to Kozma’s (1994, p. 16) spectre of students working in isolation on their own computers, evoking “memories of the teaching machine and the Skinner Box.”

In summary, it would seem that the iPad’s core educational affordances centre on the intuitive interface, seamless app integration, and the audio and video capabilities that lead to creation and collaboration rather than consumption.

The introduction of any new educational technology brings with it financial, technological, logistical, procedural, and policy issues often best addressed at a school management level. These are beyond the scope of this report. However, even when all these issues have been resolved and a functioning system is in place, there may be negative aspects to iPad usage from the perspective of an individual teacher.

Negative Aspects of iPad Usage

On the negative side, Bansavich (2011, p.7) listed the weakness of the iPads as reported by the participants. These fall into two categories. The first are those fixable by Apple. Some people reported on VGA-out issues. These can be rectified through the use Apple TV or an affordable cable adaptor. Others were concerned with the lack of a Universal Serial Bus (USB) port. Apple contends that iCloud or AirDrop replaces this outdated technology. A few people complained of the keyboard being small and difficult to use, although a physical keyboard that connects through Bluetooth is available for purchase (see also Golland, 2011). There were also those who bemoaned the iPad's inability to play Flash video, although – Flash, like Internet Explorer, is being retired. Both Apple and Android platforms now use apps in lieu of websites. App development, rather than website development, is seeing the more significant growth. Disquiet was raised around functionality, specifically with the lack of Microsoft Office products and challenges around content creation. However, MS Office is now available in the form of an iPad app with a license sign in. iOS app designers have responded to users' requests for content creation apps and this is discussed further later. Apprehension was expressed around the lack of a file management system. This is countered with the argument that the intuitive iOS design precludes the need to save files as all work is done and shared through the apps. This can be encapsulated in State of New South Wales's (2012) statement that "new operating systems often ameliorate technical and logistical issues" (p. 9). The second series of perceived weaknesses fall into the domain of the user. Some people deplored the unfamiliar functionality of the iPad, including a lack of familiar (Android) apps and the necessary learning curve associated with working with unfamiliar apps. Usage, collaboration, and confidence will resolve both of these worries. It does seem as though students are generally keen to find out what apps can do, whereas teachers seem to want to understand something in its entirety before using it.

Murray and Olcese (2011) detailed the discrepancy between what teachers say and what they actually do with technology, noting that usage "falls well below the expectations set by technology proponents" (p. 42) and that it is "often both more prosaic and less transformative" (p. 43). There is a very real danger that this powerful device is used as nothing more than "a typewriter replacement" (Ziberg as cited in Golland, 2011, p. 44) or as what can be termed as paper under glass. Puentedura (2014) calls this level of technological integration Substitution. It is often the first stage of iPad integration where a teacher converts extant documents into PDF files for students to

read on their devices; a digital document is substituted for a paper one without any change in the content or pedagogy. When teachers substitute documents the limitation lies with their confidence and experience, not with the affordances of the iPad.

Murray and Olcese (2011) argued, “technologies prosper when they extend what users are able to do in productive ways” (p. 43). Golland (2011) picked up on this productivity issue by reiterating Davis’ cautionary note “that there is very little evidence to suggest that students learn more, learn faster, or learn better by using iPads” (p. 11) and that any positive impact might be lost when the novelty wears off. This can be offset by the pedagogy of the teacher. Golland also refers to Quillen’s first observation that “application developers gear their products towards a parent-child dynamic rather than a teacher-student context” (p. 12). This is a nonsense as teachers have made the developed-for-business Microsoft Office suite of applications work in an educational context and there is no reason to suggest that they will not do the same with the iPad. Quillen’s second observation about the difficulty teachers would have when it comes to saving and accessing student made content because of the lack of a file structure also reveals the falseness of assessing an iOS model in terms of a Windows one. Apples are not pears and iPad users need to change the paradigm within which they teach.

With regard to collaboration, Murray and Olcese (2011) noted that many apps were constrained by the lack of an Internet connection or were very limited without a camera on the iPad 1. They concluded that the lack of textbook apps and the focus on consumption rather than creation and collaboration within apps mean that teachers need to rely on “a behaviorist or proto-cognitive theory of learning” and that, in spite of what they say, teachers “frequently rely on behavioral models of teaching” (p. 48). Golland (2011) argued that students sharing iPads can lead to disengagement, but concluded “collaborative iPad usage in 2:1 ratios can work, especially at lower grade levels with less cognitively challenging tasks appropriate for pairs of students” (p. 37).

While there are many apps which help young students to learn to write, Karsenti and Fievez (2013) theorized from their results that because

85% of the (6 057) students never...or rarely...used the iPad to prepare written work...in view of the fundamental importance of writing skills in elementary and high school, this finding indicates that either the iPad cannot be used for everything at school, or else the teachers had not yet realized the full potential of this tool. (p. 22).

The researcher considered that both theories might be at play. It might not be

desirable to do everything at school on any computer, let alone an iPad. When teachers have a more in-depth understanding of what they do and do not want to do with an iPad, their classroom management techniques will enable them to deal effectively with students who find temptation and distraction in the many apps and on the Internet they have access to so easily. No teacher wants students' performance to be negatively affected by these diversions.

Another negative aspect mentioned by Karsenti and Fievez (2013) is related to digital textbooks. In some cases these made no use of interactive content, in others, students could only read them online. Teachers need to be very selective in choosing the types of digital textbooks they ask students to buy in order to circumvent such difficulties. Today it is unlikely that one textbook would meet the learning needs of all students. Ed tech coaches should encourage teachers to develop their own course materials through such apps as Book Creator, Explain Everything, Showbie or iTunes U.

Golland (2011) decried the lack of a screen capture (monitoring) app for seeing remotely what students were doing. This has been resolved through the development of Apple Classroom, which allows the teacher to monitor and manage the work students are doing and to have full control over which apps will open on each students' profile. Furthermore, he mentioned the lack of a stylus, which is now also available. The difficulty of your palm resting on the device and interfering with writing was also noted. This can be resolved through the downloading of what are termed 'palm rejection' apps, such as: PDF Expert; Forge; and Ink-Write, Type and Draw In Style. Golland also talked briefly about the difficulties that arose when students use iPads for the first time without some initial basic training before the lesson starts. When students are shown how to copy and paste, they must be taught, in an age relevant way, about plagiarism and they need "clear guidelines and rules for using iPad in an academically appropriate way" (p. 39).

The foregoing discussion on the negatives associated with iPad users, rather than with Apple itself, can be encapsulated by Cuban's (1993) contention that cultural beliefs are more important than technology. What a teacher believes can or should be done with technology shapes how it is used in the classroom. Teachers who change their mindset and pedagogy about iPads find many academically appropriate ways to use them.

Aspects of iPad Usage by Teachers

Using the iPad in an academically appropriate way foregrounded the problem of "the

iPad (placing) additional demands on teachers' planning and preparation time" (State of New South Wales, 2012, p. 5). The implementation of any new technology requires teachers to get to know what it can and cannot do, and how it can be used pedagogically. Teachers who are early adopters of technology are more likely to try things on their own, while other teachers need help to do so; in both cases on-going, targeted, professional development is vital. This will prevent what Puentedura (2014) labelled as Substitution and State of New South Wales (2012) calls the "tendency of teachers to map the use of the iPad to the existing curriculum. This could be regarded as an antiquated approach in some instances" (p. 6).

To forestall this antiquated approach, State of New South Wales (2012) discusses apps as falling into three categories: instructive apps use "drill-and-practice (for) a predetermined 'task' (eliciting) a homogenous response from the user"; "manipulable apps allow for guided discovery and experimentation within a pre-determined context or framework"; and constructive or productivity apps have an "open-ended design that allows users to create their own content or digital artifact" (p. 11-12). Teachers could use all of these categories at different points in their teaching. An example of an app in each category that can be used by language teachers will be briefly mentioned. The SpellBoard app by PalaSoftware, for example, is a drill-and-practice app that can be used by any language teacher. The app allows the teacher to record the pronunciation of words for students; the pronunciation of French words is part of the app, but isiZulu words, for example, would need to be recorded by the teacher. The Learn French app by MindSnacks is a manipulable app where students go on quests. As discussed earlier, the Book Creator app, by Red Jumper, is a constructive or productivity app that can be used by language teachers to assess vocabulary through getting students to create a word-and-picture poster for a speech on a topic of their choice. These apps could be classified according to the SAMR model. The Learn French app could be classified as an example of Augmentation (direct tool substitute with functional improvement) as the activities could be done using paper, but elements such as randomization, time keeping and game playing are difficult to achieve non-digitally in a smooth and interesting manner for one player. The SpellBoard app could be classified as evidence of Modification or significant task redesign, as it allows for words to be written, voice recorded, spoken/heard, and for the activities to be repeated as often as necessary. The Book Creator app could be classified as Redefinition as it allows for the creation of new and previously inconceivable tasks; the words and pictures could be

done on a paper poster, but the ability to broadcast it, as well as to add sound and video is not something that could be done before.

Something else that could not be considered before is the mobility of the learner, both in time and place. Oakley et al. (2012) registered the change in the meaning of the term m-learning “from the mobility of the *technology* to the mobility of the *learner*” which points the way to “u-learning, or ‘ubiquitous learning’” (p.13) as the learning happens wherever the learner is.

The concept of mobile students, rather than mobile technology, can come into its own through the flipped classroom. Vikurfrettir (cited in Meyer, 2013, p. 2927) saw value in iPads being used “to flip a classroom, (giving) students more ownership over their learning”. Students use iPads to read notes or texts or watch pre-determined videos outside of school time, and use class time to check their understanding of the work, as they need to with the teacher. This is particularly successful if the teacher has set up an iTunesU course, with the relevant material in it, for the students to work through. Concerning this, Godsk (2013) suggested the use of the term “‘tabletcast’ (for) the digital media and content produced on the tablet and ‘tabletcasting’ (for) the production and/or sharing (or ‘broadcasting’) of tabletcasts” (p. 1894).

Tied to both the idea of mobile students and that of student ownership of their learning is the thought of students being able “to build and add to their curricula” (Reed, 2013, p. 2930). This is particularly evident when students are given a task to do and the freedom to present it, to the teacher and class, in a manner of their choosing. For their final History task, Grade 12 girls at the multi-case study girls’ high school were told to take any aspect of their curriculum and present it to the class. Some students made a poster, some enacted a role-play while others sang a popular song whose lyrics they had altered. One student used iMovie to make a seven-minute film on her iPad to reveal how four artists had responded to apartheid; a sculptor; a poet; a playwright; and a singer. Shortly after this she won the 2013 Apple in Education Grade 10-12 Curriculum Project (W. Robinson, personal communication, October 3, 2013). The student took a risk in going far beyond the curriculum and the History teachers took a risk in giving free rein to their students’ creativity.

Necessary risk is the term Karsenti and Fievez (2013) used to describe the benefits of iPad implementation outweighing any associated challenges. They cautioned against blindly accepting the iPads’ “breathtaking cognitive potential” (p. 1) by distinguishing between the assumed benefits and those that have been demonstrated

empirically. They are adamant that it is not the technology per se that is important, but the educational use to which it is put that matters. They characterized the role of teachers as techno-reflective rather than technophobic or technophilic.

Maher (2013) tied together different studies to communicate the strength of the link between the thousands of available apps and their suitable deployment by teachers as an important way to help students learn, even those for whom a more widely differentiated curriculum is needed. This is because the iPad is not a subject-specific, or subject-limited device, but one of great plasticity that can be used effectively across subjects and grades. In this regard, Lange and Meaney (2013) characterize apps in terms of their framing and classification; apps which exhibit strong framing give the user “no choice in the selection of the content that had to be used”, while those which exhibit strong classification have content which is “integrated with other content” (p. 4). The teacher can use both of these types of apps effectively. It could be argued that strongly framed apps support early-stage learning, while strongly classified apps allow more expert learners to integrate knowledge and present it in a variety of formats.

iPad Affordances and Ed Tech Coaches

For teachers, when it comes to doing something that could not be done before, it is a moot point whether their practice changes their theory, or their theory changes their practice. It is perception that feeds action and theory into each other, mediating and transforming the process (Churchill, Fox and King 2012). This is the locus of how teachers develop their TPACK. It is the argument of this report that this process is bettered when an ed tech coach works with teachers. Oakley et al. (2012) concluded that apart from school leadership support, and technological infrastructural support, “it is important that teachers have access to ongoing professional learning and professional networking opportunities” (p. 67). They considered a digital record or platform for teacher learning to be an important component of their PD and a way in which to enlarge its reach. The aim of this view of PD is for digital learning using the iPad to complement traditional learning in a way that is ubiquitous and, to use the quote by Oakley et al. (2012), “inconspicuous” (p.43). Blended learning allows teachers to decide on a traditional or digital presentation of different aspects of their curriculum.

The efficacy of using iPads is no longer peripheral to educational debate, nor should teachers have to rely solely on the chance learnings of their own experience, or on the randomness of their interactions with like-minded colleagues, to improve their

TPCK. This improvement is listed by Oakley et al. (2012) as ways in which teachers need pedagogical support as their focus on literacy does not negate the relevance of all the elements for non-literacy teachers:

integrate mobile devices...critically evaluate m-learning hardware and software...embed mobile technologies...facilitate and capture students' m-learning processes...assess students' traditional literacy skills through mobile technologies...(and) assess students' developing digital literacy skills" (Oakley et al., 2012, p. 19).

When this was done intentionally and systematically at one of the schools in their study, Oakley et al. (2012) concluded "many of the successes experienced at (this school) are attributable to the expertise and research of the Information Learning Technology (ILT) Coaches, targeted and sustained support from the ILT team, and the growing interest of the teaching staff" (p. 42).

Karsenti and Fievez (2013) were adamant that their "findings illustrate the crucial need to prepare teachers before iPads are introduced into classrooms...(and) the vital importance of training teachers in effective methods to integrate technological tools into their teaching practice" (p. 14). Cochrane, Narayan and Oldfield (2013) give emphasis to sustained interaction that would help teachers to integrate technology. This gives prominence to the possibility of in-house teacher training and professional development being the primary role of an ed tech coach employed by a school.

At the beginning of this section the claim was made that it is the teacher's pedagogy that determines the success or failure of iPad integration. This section has developed the argument that it is the intervention of the ed tech coach that develops the teacher's pedagogy. In South Africa, well-resourced private schools that give weight to the on-going professional development of their teachers are likely to employ a dedicated ed tech coach to facilitate this interaction.

iPad Affordances and the DISA Matrix

The affordances of an iPad (or any mobile computer such as a tablet, laptop or smart phone) are determined firstly by the software that has been downloaded onto the device, and secondly, by the use made of them. These devices have a suite of basic, standard software applications, either pre-loaded or easily purchased and downloaded, that allow for tasks such as note taking. The word processing capabilities can be categorized as perceptible affordances, because of their widespread and now taken for granted, intended and actual use by the people who own and use or share such devices. These affordances

have become ubiquitous and the user's competence in their use is expected in modern professional and personal settings. Hall and Higgins (cited in Agostini & Di Biase, 2012, p. 46) mentioned the necessity of a learning environment exploiting the extant digital technologies and experiences of students. Teachers who choose not to capitalize on what their students bring to the classroom risk becoming less capable of enriching, guiding, or contextualizing the lives their students are already living, and they risk being perceived as marginalized and irrelevant (see Oakley et al., 2012). e- Literacy in digital and online arenas has become one of the indispensable and essential prerequisites of daily life.

Affordances can arise when users apply a perceptible affordance to their personal situation, with or without direct instruction. There are two axes, instruction and apps, which lead to the plotting of four categories that need to be considered with regard to affordances in education. The two axes are instruction, with or without direct instruction by an ed tech coach, and apps whether they are built-in or purchased. All four categories have numerous affordances that can be exploited. A simple matrix, called the DISA matrix, is presented to consider the relationships between the direct and lack of direct instruction by an ed tech coach with the built-in and purchased apps. The resultant categories, shown in Table 2, are labelled as Dependent, Influenced, Serendipitous and Autonomous (DISA) Learning.

Table 2: The DISA matrix showing relationships between instruction and apps

THE DISA MATRIX SHOWING THE RELATIONSHIPS BETWEEN INSTRUCTION AND APPS	BUILT-IN APPS	PURCHASED APPS
DIRECT ED TECH COACH INSTRUCTION	1. Dependent Learning: The coach gives direct instruction to the teacher about the built-in apps and their affordances for teaching.	2. Influenced Learning: The coach gives direct instruction to the teacher about the affordances of purchased apps that the teacher will need to buy and download.
NO DIRECT ED TECH COACH INSTRUCTION	3. Serendipitous Learning: The teacher happens to discover an affordance of a built-in app that he or she has not been directly instructed in and applies it in his or her teaching.	4. Autonomous Learning: The teacher purchases and downloads apps and applies their affordances in her teaching with no direct instruction by the coach.

Even if teachers and students have access only to the built-in, standard software, there are numerous affordances that can be exploited. For devices that allow purchasing and downloading of other software applications, teachers and students have an even greater range of affordances.

Category 1: Dependent learning

Category 1, Dependent Learning, involves built-in apps and direct ed tech coach instruction. On the advice of an ed tech coach who was also an ADE, lecturers at the University of Southern California Keck School of Medicine's Primary Care Physician Assistant Program replaced a 40-page written assignment, based on secondary sources, with a five-minute video documentary that used pre-loaded software on tablets or smart phones. Students focused on health related issues such as "transportation, nutrition, housing, emergency services, and religious institutions" (Quidwai, 2016, para. 5). This was to understand the community they worked in with greater empathy and to overcome any gaps in their understanding between theory and praxis. "This project had a much greater impact on students than a typical lengthy research paper and allowed them to use their 21st century skills of critical thinking, communication, collaboration, and creativity in the service of the community" (Quidwai, 2016, para. 11). Students came to understand at first hand the difficulties in accessing health care for those without private transport or health insurance, as well as the role that cultural expectations, institutions and infrastructure have in promoting or impeding wellness, and their own role as healthcare providers. These videos were shared with class members and uploaded to YouTube. Rich and authentic learning impacted the students deeply and prepared them to be more empathetic health care providers.

This type of ICT integration exemplifies Kolb's experiential learning theory: Students planned how they would work, Kolb's active experimentation; made and showed their video, Kolb's concrete experience; watched the other videos, Kolb's reflective observation and compared their work to that of the other students, Kolb's abstract conceptualization. This increased awareness contributed to their planning of the next task, allowing for the repetition of Kolb's cycle.

The researcher is of the opinion that this category describes the development of a teacher's Technological Pedagogical Knowledge (TPK) area of the TPACK model. She also contends that most of the teaching undertaken by the ed tech coach could be characterised as dependent learning. In other words, it can be seen as a descriptor of the core work the ed tech coaches do to help their teachers integrate iPads in their teaching.

Category 2: Influenced learning

Category 2, Influenced Learning, involves purchased apps and direct ed tech coach instruction. The Decide Now! app is an inexpensive version of a TV game show's random spinning wheel, that does not come standard on any device and must be purchased

by each individual mobile device owner. The user labels individual segments of the wheel with a set of options. When activated, the wheel spins and stops randomly on one of the segments. A novel use for the app arose when ETC3 brokered a relationship between her knowledge of the app and a primary school isiZulu teacher's desire to teach vocabulary using iPads. Direct instruction by the coach led to the successful ICT integration of the iPad and app in a game-show type situation as the sounds, colours and spinning of the words on the screen added an element of fun to the lesson. It was also successful because students rather than the teacher controlled the iPad used by their group.

Category 3: Serendipitous learning

Category 3, Serendipitous Learning, involves built-in apps and no direct ed tech coach instruction. This occurs when a user makes serendipitous discoveries about the built-in apps and their usage; however, this category is difficult to document.

Category 4: Autonomous learning

Category 4, Autonomous Learning, involves purchased apps and no direct ed tech coach instruction. When teachers begin to understand the affordances mobile devices have, and how apps can be used in their teaching, often they begin to experiment on their own, and this often leads to the digital novel use of apps. Teachers personalize their instruction according to what they know of pedagogy, content, and technology. They begin to expand their TCPK and tailor-make their lessons to suit their local conditions. In Puentedura's (2014) terms, they redefine their teaching. It can be powerful and empowering to be in this situation.

In this regard, two primary school language teachers each decided to use the same purchased iPad app, Book Creator, with their respective classes, after ETC3 had demonstrated it to them and let them try it for themselves on their personal iPads. However, the coach did not give specific instructions as to how the app should be used, and the teachers applied its affordances to their teaching themselves. In the case of First Additional Language (FAL) teaching, the Grade 5 isiZulu teacher wanted her students to give a thirty-second speech using ten of the words they had already learnt. She decided to let the girls use the school's bank of iPads, as they did not have personal devices. Girls were shown how to use the app and given one lesson to make a themed poster combining the words they chose from their vocabulary list, with their choice of pictures from the Internet. In the next lesson each girl had a turn to project her poster on the iPad through the Apple TV onto a big screen as a memory aid for her speech. This was a

far quicker, and less messy process, than the girls making a cardboard poster. It also meant that the work was done entirely at school with no input from parents or older siblings. Girls chose the ten words they wanted to use, and then checked that their spelling was correct, which increased their learning. The pictures and words gave them the confidence to speak with greater ease and fluency, and had the added benefit of keeping the rest of the class interested, and respectfully quiet, during each speech. Furthermore, every girl heard the vocabulary words used in short sentences; the differing pronunciations would have made them work harder mentally to identify the words and match them with their own pronunciation and with that of the teacher. Another important benefit was that this was an authentic exercise, as students are required to give speeches in different languages and on different topics throughout their school career.

Again, this is an exemplification of Kolb's theory. His active experimentation is shown in how the students chose their words and planned the layout of their poster. Kolb's concrete experience is revealed in their making and showing their posters. His reflective observation came through when students watched the other videos. Kolb's abstract conceptualization was manifest when they compared their work to that of the others. Lastly, Kolb's cycle was repeated when these sharpened perceptions became the basis of their understanding for their planning of the next segment of work.

In a similar way, the Grade 7 English first language teacher, asked her girls to use their own iPads to design a magazine cover. In previous years, the teacher had marked the cardboard posters herself and displayed them on the walls of her classroom. This time, most girls put more effort into the design of their digital poster, as the whole class was to be involved in discussing their work when it was projected onto the classroom screen through the Apple TV. Their peers were more forthright than the teacher in both their facial expressions and verbal judgements. Those girls who had wasted time or not prepared diligently could see the superior quality of their friends' work and realized they had let themselves down. Girls were able to see the relative effects of different graphic elements, such appropriate picture selection, headline wording, font type, font size, and colour combinations, on each poster. The whole class was able to have much richer discussions around the specific elements of the task than in previous years, which led to greater learning around the basic elements of graphic design and the impact each could have.

This is a third manifestation of Kolb's experiential learning theory. Students' planning of their magazine cover relates to Kolb's active experimentation. His concrete

experience can be noted in the projecting of their cover through Apple TV. They would have reflectively observed the showing of the other covers and then conceptualised in an abstract manner their work as compared to that of the others. Yet again, Kolb's cycle would have been evident when the students took these insights with them into the next assessment.

Kolb's experiential learning theory

In summary, the ICT integration by the Physician Assistant Program lecturer, the isiZulu teacher, and the English teacher, all exemplify Kolb's experiential learning theory. In all three cases, students had to plan how they would do their work, which Kolb characterized as active experimentation. Their making of their poster or video and the presentation of their work, which Kolb called concrete experience, followed this. While they listened to the other speeches or watched the other videos, they could be identified as undergoing Kolb's process of reflective observation. This led them to think about and evaluate their own choices when compared to those made by the others in what Kolb represented as abstract conceptualization. In turn, this fed into the planning they did for their next presentation and Kolb's cycle was repeated.

All of these examples led to co-operative, collaborative and collegial learning. Students who are engaged in authentic tasks are likely to learn more and to learn more deeply than those who do not engage in such tasks. Teachers who are supported by ed tech coaches are more likely to develop such tasks.

Conceptual framework

The literature survey looked at the way that individual teachers use iPads in their classrooms, but I have not found South African research about the role of ed tech coaches and their impact on teachers' professional iPad usage. I put forward the claim that it is the role of the ed tech coach that makes the crucial difference as to how the affordances of an iPad are used by teachers. It is postulated that 'Category 1: Dependent learning' in the DISA matrix describes what happens in the Technological Pedagogical Knowledge (TPK) area of the TPCK model and further, that it represents the core of how the ed tech coaches develop iPad integration in their teachers. Further, the idea is put forward that ed tech coaches may have gone through the stages of substituting, augmenting, modifying and finally redefining the content they taught, as suggested by Puentedura's (2014) SAMR model, before they were appointed as ed tech coaches, and that they used this to develop pedagogical competency in the teachers. Moreover, it is

proposed that this SAMR model details what happens in the Technological Content Knowledge (TCK) area of the TPACK model. It is argued that the DISA matrix elucidates teachers' development of technical and professional knowledge, their TPK, while the SAMR model illuminates teachers' application of that knowledge in their teaching, their TCK.

With this understanding of the literature in mind, the grounded theory methodology of this qualitative study is presented. Then due consideration is paid to the different elements of the research process, namely: Research Strategy, Purpose and Design; Selection of the Schools and Participants; The Three Phases of the Research; Audio Recording and Data Collection and Transcription.

CHAPTER 3: METHODOLOGY

The researcher deemed a qualitative research approach to be the most productive way of discovering the detail of how ed tech coaches help teachers to integrate iPads into their teaching as the literature contains so little, if anything, about how they achieve this. A quantitative approach to examine the nature of how participants interact and what the quality of their relationship might be would have been inappropriate. The point of inductive qualitative research is for the researcher to analyse then interpret the data to derive meaning, and so is necessarily about the subjective meaning systems of human activity. This aligns with Geertz's (1973, p. 311) declaration that such cultural analysis is not "an experimental science in search of law, but an interpretive one in search of meaning."

Grounded theory was chosen as a methodology because of the aptness of its applicability to the research question. The purpose of grounded theory is to produce rich descriptions of meaning systems, then to generate theory inductively from the depth of those descriptions. Importantly, Corbin and Strauss (2008) define it as using qualitative data analysis to develop theory. According to Scott and Morrison (2007) grounded theory is founded on three tenets: categorisation; generalisation or abstraction; and theoretical reflection. The researcher is the interpreter in this process; therefore it is imperative that he or she is very familiar with the data. He or she determines which aspects of the data are important, how they are coded and categorised and how they relate to each other in a framework. Scott and Morrison (2007, p. 121) refer to Pole and Lampard's assertion: "The discovery of theory within the data is a construction of the researcher, brought about by his/her knowledge of the data and the capacity to identify codes and concepts within it."

Normally coding is used as a data analysis technique but the researcher used categories arising from the data to achieve the same end. In the first place, the researcher would group the raw data or information into categories that deal with broadly similar ideas in an inductive process. This can be termed as the open coding of data. At all times, the deciding rule underpinning the development, populating or discarding of categories was whether or not the data could offer possible insights into the research question. According to Geertz (1973), it attempts to separate out what the researcher sees

as relevant and applicable in order to begin answering the research question. It allows for much back-and-forth between the raw data and the emerging categories as the researcher begins to shape ideas in the crystallising categories. These categories are altered and refined until each holds one idea. They are considered saturated when the meanings behind each complex idea are as fully detailed as the data permits. This saturation implies a breadth and depth that contains nuances of description allowing for a subtlety of understanding to elucidate the meaning of each idea and category. Moreover, their importance, relative to each other, begins to emerge. This tenet could be stated as the researcher understanding the ideas behind the data.

Secondly, the categories are then embodied in general or abstract terms. Here the relationships between the categories and their interplay are set out through what is termed axial coding. The weighting and then ordering of the categories becomes important as they do not all carry the same authority or have the same value. This leads to the logical pathways between categories being mapped out. Once the researcher has understood and interpreted the data and is able to make inferences and discuss implications, the analysis could be considered to be thick if it meets Geertz's (1973, p. 312) criteria of "a stratified hierarchy of meaningful structures in terms of which (the relevant behaviours) are produced, perceived, and interpreted". However thick the description, it must not be assumed that it will be a complete description of the event or relationship. In other words, there is a variety and richness of relevant detail that has incorporated differing points of view and perspectives in an attempt to explain what has transpired between the individuals or groups concerned, but this could never be exhaustively codified. This tenet could be stated as the researcher understanding the value of the categories and their relationships.

Thirdly, the abstractions are put into an analytical framework that allows for a more theoretical interpretation. Geertz (1973, p. 314) terms this as "sorting out the structures of signification." This framework embodies the first principles the researcher has drawn out of the open and axial coded categories. Perhaps the framework so developed need not necessarily be hierarchical, but it must allow for a causative flow of concepts. It is also possible that the framework could be re-arranged as new data, categories, relationships and pathways come to light in later research. This tenet could be stated as the researcher understanding what the abstract terms reveal about the developing theory and the possible implications of these terms.

To be able to do all this, it is important that the researcher does not approach the raw data with preconceived ideas as to what should be there or which categories should

prevail. There is no situation or sense in which data must be fitted into pre-existing categories, as it is never appropriate to do this. Of course, complete neutrality or objectivity on the part of the researcher is neither desirable nor possible. The researcher must have some idea of what might come to light as without any tentative or rough thoughts in mind it would be impossible to make any sense at all of the material under consideration. Keeping an open mind, but not an empty one, helps the researcher to be responsive to the data, even to be surprised or puzzled as to what is, or is not, contained therein. Furthermore, even at the end of the whole process, not everything can be fully known as the research might be constrained by any number of factors, including the researcher's inability to discern categories, relationships or elements of a framework that might allow for a better explication of the research question.

Scott and Morrison (2007) identify a number of possible inherent dangers in the researcher being solely responsible for codifying data and for developing the categories and framework. Quantitative research is always concerned with issues of the reliability and validity of the research process. A quantitative study is said to be reliable if another researcher could repeat its findings and it is said to have validity if its findings are believable or genuine, whereas in qualitative studies reliability and validity have different emphases. To counter possible claims of unreliability or invalidity, the qualitative and grounded theory researcher must be as honest and open as possible about the data collection and its analysis, in other words about both the process and its product. The researcher must also explain the context in which the data is collected as this impacts on what is collected and how it is collected. It is also part of the process of grounding the ideas and categories in the data.

Scott and Morrison (2007) discussed Guba and Lincoln's idea that qualitative reliability should be founded on dependability and confirmability. The latter proposed an auditor to rectify the possible negative effects of the researcher's role in being the sole collector and analyst of the data. The auditor, in this case the researcher's supervisor, was given copies of all the transcripts before the analysis. Accordingly, he confirmed that appropriate procedures had been implemented, rational strategies and methods followed and that sensible conclusions were drawn. In effect this was an assurance that the findings were grounded in the data, that logical inferences had been made and that the categories and the framework they were fitted into was apt.

Scott and Morrison (2007) also discussed Guba and Lincoln's early suggestions

that validity is contained in studies that are credible, transferable, dependable and confirmable. When faced with arguments that this could lead to a formulaic approach to research, they later advocated for a further four validity criteria: fairness, educative authenticity, catalytic authenticity and empowerment. The researcher was careful to treat all participants' perspectives fairly and not give prominence to some at the expense of others. Educative authenticity is concerned with participants' self-education. The study uncovered various ways in which the coaches were deepening their own professional development but did not put forward ideas for their self-development, other than promoting those that they were already engaged in. Catalytic authenticity is likely to be realised when the study is presented to the rector, heads, coaches and teachers as it will provide some insight into what is currently happening and then might be used to suggest possible areas for future ed tech decision-making. Certainly in asking coaches and teachers to reflect on and discuss their own practice the researcher gave them an opportunity to stand back from their work and assess it within the wider context of the school, empowering them to make informed choices in their professional lives.

Another hazard that the researcher must face, according to Geertz (1973), is the presumption that he or she has understood everything about everything and that the analysis, interpretation and framework encompass the singular meaning to be derived from the data. It is the researcher's open mind and ability to give import to the information that enables the data to be analysed, the categories to be developed and a framework to be synthesized. The framework allows for concepts grounded in data and organised in categories to be ordered in such a way that it allows the researcher's interpretation to be critically probed by others. However, this probing might well reveal aspects of the analysis, interpretation or framework that others do not see as valid or supported by the data. Scott and Morrison (2007) offer a more detailed explication of this.

In addition to this possible misinterpretation of the data, Geertz (1973) maintains that grounded theory and qualitative researchers may not find it possible to draw definite or definitive conclusions about the data. It is to be hoped however, that they would offer a data-driven and data-supported perspective that could deepen understanding of their research area, even if it is incomplete or its conclusions are tentative. The thicker the description the more confident the researcher would be in drawing conclusions from the data as a more comprehensive understanding of each participant's world view had been reached. Thicker description also results in ideas and categories being well established or well-grounded in the data, making them consistent

with the evidence. This leads to a greater degree of consistency and corroboration that provides confidence in the validity of the study as absolute certainty is never possible.

I was interested in how ed tech coaches developed teachers through coaching them in integrating the affordances of iPads into their teaching. As explained above, it was clear that a qualitative approach, rather than a quantitative one, would ascertain insight into some of the complexity of the phenomenon, even if any conclusions might be tentative or incomplete. Accordingly, it was decided that a grounded theory approach would be appropriate to probe what was happening between the ed tech coach and the teacher. In this approach, the information from the interviews and observations formed the raw data. The categories could not be known before the study was undertaken as it would not be a matter of imposing categories on the data, but of letting the analysis reveal them through inductive reasoning. While it is important to describe the phenomenon under study as comprehensively as possible, as Scott and Morrison (2006) affirm, it is the analysis of the description, of its meaning, that is of paramount import. Knowing the ‘why’ allows for a more nuanced perspicacity than knowing the ‘what’ in any circumstance.

The raw data to be analysed in this multi-case study was garnered from observations and semi-structured interviews with ed tech coaches and teachers. A school with five ed tech coaches was approached as the site for the study. One coaching session between each coach and teacher pair was observed. Then the researcher developed a set of 15 questions for semi-structured interviews with the participants. When these answers did not provide the detail she thought she might find, she developed a set of 31 more specific questions from the conceptual framework for a second round of semi-structured interviews. The coaches and teachers were encouraged to relate examples from their own experience through first-hand accounts of their practices. It was hoped that the observations and the answers to both sets of interviews would reveal how the coaches and teachers related to each other, as well as what happened during one snapshot coaching session and how the coaching was manifested in the teachers’ possibly changed pedagogy. The researcher was hoping for detailed responses that would give both depth and breadth, revealing a finely textured perspective and so lead to an understanding and considered perspective of the phenomenon.

Qualitative Research

In choosing to do inductive qualitative research, the researcher carried out a multi-case

study to flesh out the detail of what happened when ed tech coaches instructed teachers about the affordances of iPads. It was hoped that the multi-case study would describe how the group of ed tech coaches worked in one organisation of a group of schools. The richness of the detail would become apparent as the coaches and teachers were employed at different schools, each with their own policies, procedures and professional norms, although they all fell under the umbrella of one organisation. A multi-case study design would allow the researcher to interview and observe ed tech coaches and teachers in their school setting as this is an important component of teaching and learning.

The researcher thought it was vitally important that both ed tech coaches and teachers were informed of the research question underpinning the study. This would help them to understand the context of the observation and the interviews and what the ultimate goal of the research was. The more open and reflective the participants could be, the more information the researcher would have access to, enabling a thicker description to be compiled. A blind or double blind quantitative study had the potential to disastrously obscure those critical responses the researcher was seeking. This could have hindered participants from being as forthcoming as possible and it could have hidden elements of the relationship between the coach and the teacher, making it less likely that a thick description with rich details would be assembled. The researcher was looking for a type of qualitative data that revealed first-hand knowledge. It was important that the participants reflected on their own practices and communicated their perceptions of any changes to their pedagogy. If the coach or teacher mentioned something then the researcher understood this to mean that it was important to or significant for them. This is in line with Blumer's "symbolic interaction" (Scott and Morrison, 2008, p. 2) where the researcher's response is to the meaning the participants give to their actions. This helped the researcher to understand which behaviours or acts in the raw data could be separated out into different categories as important in the open coding phase.

The study used interviews and observations to develop a case study of how five ed tech coaches at one school helped teachers to integrate iPads and their affordances into their teaching. The information garnered from the field, through nineteen interviews and four observations were analysed into categories. Then, more general or abstract connections were made to uncover the meaning revealed by the data through axial coding. Finally, these connections were developed into a framework to reveal the relationships between them. As Geertz (1973) suggested, the thickness of the description gives context to the study and the analysis integrates those pertinent

observations, as integration cannot be understood in isolation from its context.

The research was conducted in three phases: the ed tech coaches and teachers were interviewed twice each and an observation was made of one of their coaching sessions. The interviews and observations were audio recorded and transcribed by the researcher. The first round interviews were referred to as the background interviews, while the second round of interviews was termed the specific interviews. The first level of analysis, the open coding, needed to develop categories within the data and was carried out individually on each interview. First, all the specific interviews of the ed tech coaches were analysed, then the specific interviews of the teachers were done. Next, the background interviews of the ed tech coaches were analysed, then the background interviews of the teachers and lastly, the observations were done.

The specific interview with the ed tech coach of the boys' high school was the first to be analysed. Categories discerned from this formed the basis of the categories of the other interviews and the observations. Most of the categories were derived from this interview, but other categories were added when coaches or teachers spoke of things not mentioned in this first interview. The researcher started with this interview because this school was given the number 1 and, more importantly, because the coach had prepared particularly thoroughly for the interview, going so far as to type up her responses to the questions, although additional material was also mentioned where she felt it to be appropriate. The researcher undertook thematic content analysis of the interviews and observations. Both recurring and distinctive themes in each analysis were written up in the categories inducted from the data. Then the relationships between the categories and their interplay were put into abstract categories through what is termed axial coding. The weighting and then ordering of the abstract categories developed into a first principles' conceptual framework called "An Emerging Portrait of an Ed Tech Coach". This means that the findings and the analysis thereof are discussed together in the chapter titled 'Portrait of an Ed Tech Coach'. Information on the following will now be discussed: research strategy, purpose and design; selection of the schools and participants; three phases of the research; audio recording; data collection, transcription and analysis.

Research Strategy, Purpose and Design

The research strategy was based on the grounded theory approach discussed earlier. The researcher had an inkling of what the participants might answer having read extensively as

to how teachers were using iPads in their classrooms and listened to the conversations of a handful of colleagues who were using iPads, a few of whom later became participants. From this, a conceptual framework of first principles was generated that it was hoped would allow the researcher to access the richer breadth and depth of the participants' practices and knowledge. From the earliest overheard conversations between ed tech coaches and teachers and from the literature review, the researcher anticipated that the analysis of this data would elucidate the conceptual framework and possibly allow for an emerging model of an ed tech coach to be put forward.

From the conversations and literature review, the researcher inductively drew up semi-structured interview questions. These, together with observing coaching sessions and doing the transcriptions herself, positioned the researcher as the nexus of the study, connecting the different participants and elements. Scott and Morrison (2008) refer to this as the researcher being deliberately self-conscious and systematic in doing the analysis. In using the grounded theory approach, as communicated earlier, the researcher is solely responsible for codifying data and for developing the categories and framework, although her supervisor acted as an auditor in this process. This follows Scott and Morison's (2007) discussion on Guba and Lincoln's idea that qualitative reliability should be founded on dependability and confirmability, where an auditor is proposed to rectify the possible negative effects of the researcher's role in being the sole collector and analyst of the data. The auditor, my supervisor, was given copies of all the transcripts before the analysis. Accordingly, he confirmed that appropriate procedures had been implemented, rational strategies and methods followed and that sensible conclusions drawn. This was a check that my findings were well grounded, that inferences made from this were cogent and that the categories were useful and the resultant framework apposite.

Without being intrusive, I was able to let the participants talk for themselves and began to understand their different perspectives that were influenced by their individual backgrounds and agendas as much as by the expectations of their schools. In some cases they confirmed what I had suspected might be the situation, but in others their answers surprised me with their openness, vulnerability and transparency. They welcomed me into their world, strengthening the relationship between participant and researcher and enabling the latter to understand their work in terms of their personal perspective. This made it easier for me to incorporate different points of view and

perspectives, as I saw how each functioned in their school, as well as some of the challenges and opportunities they faced. As a colleague and not an outsider, some of Geertz's (1973) concern about researchers having "a lack of familiarity with the imaginative universe (of the participants) within which their acts are signs" was avoided. This is especially important given the pivotal role the researcher played in conducting the study. At the very least, the ed tech coaches were all concerned that their teachers used the iPads to achieve their teaching goals. The teachers were all concerned about using the technology to teach better and to help their students learn more effectively. None of them were interested in the iPad for its own sake but wanted to use it as one tool at their disposal to improve their teaching and the students' learning.

Interviews and observations were undertaken to develop a detailed, school-focused case study of how five ed tech coaches helped five teachers integrate iPads into their teaching. The nineteen interviews of the ten participants and the four observations of four pairs of them were categorised into open codes and then abstracted into axial codes. The connections or themes were formulated into a framework to suggest a model of an emerging ed tech coach.

Selection of the Schools and Participants

The choice of Independent Examinations Board (IEB) schools that prescribed iPads constrained the sample parameters. The number of dedicated ed tech coaches in IEB schools in Johannesburg is too small to allow for representative sampling. Further, the small sample size does not allow for representative race, age or gender sampling: four of the coaches were female and one was male; all were white and in early middle age. Further, the teacher participants were also not representative as their choice depended on the ed tech coach: four of the teachers were female and one was male; two were white and three were black; all were in early middle age.

For ease of access, the researcher chose to work within a bounded system of a group of seven schools, but focused on the five full-time schools. These are held together by their common values, identity, educational approach and physical location, as one school, one of the largest of the IEB schools in South Africa. The school is a not-for-profit, private, well-resourced church school. All five schools share a campus of 108 hectares. Some facilities, such as the chapel, the hockey Astros, and the aquatics centre are shared facilities. The schools each have their own classrooms, computer labs and library, although the libraries for the primary school girls and high school girls are in

one building and resources are shared.

Description of the schools

These five schools run as distinctive entities, each with their own head, staff, students, and curriculum, while belonging to one legal entity under the oversight of a governing council. All the schools subscribe to a common honour code and value system and are branded as one school. The five heads and their deputies oversee the day-to-day running of their individual school. They report to the executive head, the rector, who oversees the vision, mission, fund raising, and advancement and so on, of all the schools. The rector answers to the school's highest decision-making body, the governing council.

One school is co-educational and four are monastic. The junior primary school is co-educational with students from Grade 0 to Grade 2. The primary schools have students from Grade 3 to Grade 7. The high schools have students from Grade 8 to Grade 12. Grade 12 is also known as the matriculation year. Synergy, the deliberate and active interaction and co-operation between the primary schools, and between the high schools, is pursued where appropriate, although it is sometimes difficult to achieve outside of calendarised cross-campus cultural days.

I was not concerned with two of the seven schools, the sixth and the seventh, as they are not full-time schools. The sixth school is a rural, residential, outdoor educational facility that forms a temporary subset of the primary and high schools. The seventh school provides curriculum enrichment and extra tuition in English, mathematics, accounting and the sciences for more than 1 300 previously disadvantaged Grade 9 to Grade 12 students from over 160 schools in townships and informal settlements across Gauteng on Saturdays. This school runs on the campus on 26 Saturday mornings throughout the year. Paid subject specialist teachers, academic tutors and senior students from the two high schools undertake the teaching. It also provides a mathematics and science teacher development programme for the up-skilling for more than 1 400 early childhood education and foundation phase teachers in the Gauteng and Limpopo provinces. Furthermore, 43 pre-service, mentored, intern teachers undertake job-embedded training within the different schools and read for their degrees through the University of South Africa (UNISA), a distance learning university. On a yearly basis, they rotate through at least two of the schools, according to the grades they wish to teach and their teaching subjects, with a special focus on subjects facing critical teacher shortages. Their university fees and course materials are paid for and they receive a stipend. They are

considered full members of the teaching staff. This seventh school is funded entirely by corporate social investment funding, grants and donations.

Approval and ethical considerations

The rector was approached in person for approval-in-principle. Once this was obtained, the heads of each school were approached through email for approval before contact with the coaches and teachers were made. The ed tech coaches and teachers were also contacted by email. Ethical approval was obtained from all involved and submitted to the university's Ethics Committee for final approval. Once this had been received, permission to undertake the research was gained by the school's chair of council, rector and heads, while consent to participate, to be interviewed and to be audio recorded was received from the ed tech coaches and teachers. These consent letters have not been included as they were written on school letterhead paper and the school is named several times therein.

Interviews

The background questions of the first interviews with the five ed tech coaches dealt with very general issues such as "What made you help this particular teacher to use the iPad as an ed tech device?" and "What did you show the teacher how to do?" In their first interviews, the teachers were asked the same general questions: "What made you ask this ed tech coach for help in using the iPad as an ed tech device?" and "What did the ed tech coach show you how to do?" The four observations of the teaching session with the ed tech coach and teacher were roughly hour-long observations as a snapshot of their relationship. Although ETC5 and T5 had an excellent working relationship, they asked not to be observed because they met sporadically. The second interviews with the five ed tech coaches, dealt with detailed issues taken from the conceptual framework, such as "Can you give examples of when the iPad was used to introduce new material that students could work through at home, with the teacher checking for student understanding and resolving misconceptions during class?" The same specific questions were asked of four of the teachers, as T5 asked not to be interviewed for a second time, as he had not used the iPad in his teaching since his first interview six months previously.

Selecting the participants

The researcher had no choice as to the selection of the ten participants, except in one case. This is in line with Scott and Morrison's (2007, p. 121) dictum: "The selection of

research participants cannot be fully known at the outset of the research.” The five ed tech coaches were all invited to participate and they all accepted. Each chose a teacher from their school to bring the total of participants to ten. Four of the teachers were the first choice teachers of their respective ed tech coaches. However, in the case of the boys’ primary school, I chose the third teacher who had been approached by the ed tech coach. This was because the observation between the ed tech coach and the first teacher could not be used as it was a lesson on using a Mac and not an iPad. This first teacher did not have an iPad and had no immediate desire to teach with one. The ed tech coach then approached two other teachers. I observed an iPad lesson between the ed tech coach and the second teacher and shortly afterwards between the ed tech coach and the third teacher, both of which went well. However, I preferred the clarity of answers that the third teacher gave and the way he reformulated what the ed tech coach had said in order to check that his understanding was on track. The observations between this ed tech coach and the first two teachers of the boys’ primary school were not transcribed and there were no further interviews or observations with or about them and they played no further part in the study. I let them know why they had not been selected and thanked them for their time and willingness to be considered as participants in the study.

The researcher’s relationship with the participants

The researcher worked at the girls’ high school as a librarian and attended monthly meetings with the rector, a deputy head from each school, all five ed tech coaches and the technology manager and/or director of the e-Learning Committee, previously known as the Educational Technology Committee. The boys’ and girls’ high school librarians were historical appointments to the committee dating from when it was first set up when desktop personal computers were installed at the schools, years before iPads were introduced. Since the retirement of the boys’ high school librarian the new appointee has not attended the meetings.

I was aware that my extant working relationship with the five coaches and girls’ primary and high school teachers might mean that all parties would take the same things for granted and unintentionally this might make some elements opaque. However, I hoped that being aware of this and by making the participants aware of the same and the stated focus on clarity would mitigate this concern. It was also hoped that this same relationship would allow for easier access to the thoughts, intentions and teaching situations of the participants because they were being interviewed and observed by a fellow teacher

and colleague, rather than an outsider. This countered Geertz's (1973) concern about the researcher's lack of familiarity with the participants' imaginative universe. I knew some of the coaches and teachers far better than some of the others because of my particular job situation. The primary and high school girls' ed tech coaches worked and held meetings with their respective teachers in the library office, but the other three coaches would only be seen at the monthly e-Learning Committee meeting and I had no prior contact with the three teachers they chose. The focus now turns to the contact the researcher had with all the participants in the three phases of the research.

The Three Phases of the Research

The interviews and observations were conducted at a time and place of the participants' choosing, usually in his or her classroom or office, over eight months. Two interviews were conducted in a small teaching room in the girls' library. Two observations were done in a small meeting room at the boys' primary school.

Phase 1: semi-structured background question interviews

The first phase consisted of a semi-structured interview that was audio recorded and transcribed by the researcher. It covered background information about the interviewee and when they started using iPads. Each ed tech coach and teacher knew they were to be asked the same questions. These interviews were known as background interviews. There were ten interviews: one from each of the five ed tech coaches and one from the teacher selected from their school.

At the beginning of each interview the researcher stated the day and date and although I smiled, made encouraging sounds such as "Mmm" and nodded, I tried not to interrupt unless I felt there was a need to clarify something or draw the participant out into giving more detail. I let the interviewee answer the questions that were on the typed A4 page I had given him or her, while taking handwritten notes. This had three functions; to provide a backup in case the audio recording failed although it never did; to give the researcher something to do other than stare intently at the interviewee; and to give the interviewee time to answer fully without interruption. Phase 2: ed tech coach and teacher one-on-one observations

The second phase was the observation of a one-on-one teaching session by the coach with the teacher of his or her choosing that was audio recorded and transcribed by the researcher. Each pair knew the other pairs were to be treated in the same manner. There were four observations as the junior school ed tech coach and teacher did not meet

formally as the others did, but chatted informally whenever each had something to discuss with the other.

At the beginning of each observation I stated the day and date. I seldom spoke thereafter, although I smiled, made encouraging sounds such as “Mmm” and nodded. Again I took handwritten notes for the same three purposes; to provide a backup in case the audio recording failed although it never did; to give the researcher something to do other than stare intently at the pair; and to give the pair time to interact without the researcher intruding.

Phase 3: semi-structured specific question interviews

Although the ed tech coaches and teachers answered the background questions fully, I was not satisfied with the questions I had asked as I felt that they did not get to the heart of what I thought might be happening between the ed tech coach and the teacher. Accordingly, I took the thirty-one points raised and discussed in the conceptual framework and put them to the ed tech coaches and teachers as questions. The conceptual framework was based on what I had read for the literature review and other informal magazine articles or blog posts and on what I had seen and heard while listening to ed tech coaches and teachers talking about what they were doing. I realised that the background questions had been inadequate in uncovering the depth and breadth of the knowledge and experience the participants had.

The third phase was a semi-structured interview that was audio recorded and transcribed by the researcher. These interviews were known as specific interviews. Each ed tech coach and teacher knew they were to be asked the same questions. There were nine interviews as the teacher from the boys’ high school had not yet implemented any of the teaching he had received from his ed tech coach; he said he had nothing to add to his initial interview which had been six months earlier.

Again, at the beginning of each interview, I stated the day and date and although I smiled, made encouraging sounds such as “Mmm” and nodded, I tried not to interrupt unless I felt there was a need to clarify something or draw the participant out into giving more detail. I let the interviewee answer the questions that were on the typed A4 page I had given him or her, while taking handwritten notes. As before, this had three functions; to provide a backup in case the audio recording failed although it never did; to give the researcher something to do other than stare intently at the interviewee; and to give the interviewee time to answer fully without interruption.

Audio recording

The interviews and observations were recorded using the Just Press Record app on my iPad or iPhone, whichever I had to hand. The app was suggested by ETC3 of the girls' primary school. She had heard of it from a blind friend in the United States of America who used it extensively. The audio recording could be shared via Message, Mail, WhatsApp, Google Drive, added to Notes, imported with WhatsApp, or imported with Google Drive. It could also be transcribed and the transcript shared via Message, Mail, Twitter, Facebook, WhatsApp or added to Notes. The transcript could also be removed from the recording.

After the recording had been made, I had it transcribed by the app. Then I emailed the transcription to myself and saved it as a document. It was a continuous stream of words with neither punctuation nor pause. I listened to the saved recording while reformatting, retyping or editing indistinct or incorrectly transcribed words. The quality of the recording and transcription was good and the formatting and retyping/editing went relatively quickly for the interviews. One difficulty with the transcription was the rendering of South African accents by an app developed in America. There were some funny and some lewd words that were rendered in the transcriptions that were definitely never spoken during the interviews and observations. One minute of interview recording took about ten minutes to edit, retype and reformat.

The observations were more difficult and time consuming, especially if the ed tech coach and teacher swallowed their words, talked at the same time, talked in rapid succession, or finished each other's sentences. It was particularly difficult when the ed tech coach and teacher of the girls' high school talked as they were both quietly spoken. The sensitive microphone picked up the sounds of cars travelling on the road about 50 metres away and this rendered some words indistinct. However, I soon recognised each participant's speech idiosyncrasies from the individual interviews and this helped with the transcription of the observations. One minute of observation recording took about one hour to edit, retype and reformat.

Data Collection and Transcription

Semi-structured interviews were the main research instrument. The answers given in the specific questions' interviews provided the bulk of the data, but valuable insights were also gained from the background questions' interviews and the observations. The initial plan had been to complete the interviews in Phase 1 before moving onto the observations in Phase 2. However, the reality of co-ordinating meetings of between

thirty and sixty minutes with ten teachers at five schools with their own timetables, individually and in pairs, meant that interviews and observations were done when participants were available, especially when the Phase 3 interviews were added.

The permission letters stated: “The last phase, once the interviews and coaching sessions have been transcribed and sent to the participants for review, is a final interview to align my transcriptions with their recollections. Any anomalies will be resolved through discussion until all parties are satisfied that an accurate account has been rendered.” No participant showed any interest in reading or listening to his or her interview or observation transcripts, although I had said several times that I would make them available. In the end I emailed each participant their interview and observation transcripts, asking them if it was a fair and accurate reflection of what had been said. Unanimously, their comments were positive and can be summarised in the words of T3: “All the information is detailed and accurate. You have captured how I feel and our discussion.”

The three phases of the research are not to be understood as representing a time schedule: sometimes an observation was done first; sometimes it was the interview with the ed tech coach; sometimes the interview with the teacher was done first; sometimes most of the interviews and observations from one school were completed and transcribed before those of another had even been started. This meant that the data collection and transcriptions of the audio recordings happened in no particular order between May and December 2017. The analysis was done between January and April 2018.

Conclusion

From the beginning it was decided to use a grounded theory approach. I wanted to uncover the first hand experiences of the ed tech coaches and the teachers. Accordingly, this type of qualitative data was brought to the fore through the observation of coaching sessions and semi-structured interviews with ed tech coaches and teachers in a multi-case study. Using the first principles embodied in the conceptual framework, the first-hand accounts of their practices were unpacked and categorized according to their own internal criteria.

Before the emerging portrait of an ed tech coach is presented, the instantiating links between the points made in CHAPTER 1: CONCEPTUAL FRAMEWORK and CHAPTER 2: LITERATURE REVIEW ON AFFORDANCES are now advanced.

The instantiating links between the points made in the literature review and those

made in the conceptual framework are now advanced. Examples are given to show how elements of the TPCK model are reflected in the data, as are examples revealing elements of the SAMR model in the data.

CHAPTER 4: INSTANTIATING LINKS BETWEEN THE TPCK AND SAMR MODELS AND THE DATA

Mishra and Koehler's (2006) TPCK framework is an integrative model that lays bare the areas of expertise teachers need to develop and the links between these. It is not intended to suggest or prescribe how this expertise develops. Puentedura's (2014) SAMR model illustrates one way to understand how teachers develop and integrate their use of technology, but I would suggest that some provisos must be noted. Firstly, teachers are not expected to work through the four stages of the SAMR model in the order they are presented. Secondly, when a teacher has moved from a less integrative stage to a more integrative one, he or she is not prohibited from returning to an earlier stage. The most important proviso, thirdly, stands outside of any model. While the teacher's pedagogy will determine his or her approach to using the affordances of iPads, this pedagogy is changed more directly or more easily through the mitigation of an ed tech coach.

None of the coaches in this study underwent specific training to become ed tech coaches. All five are teachers with a strong personal interest in technology, although with differing areas of interest. Similarly, the teachers ranged along a spectrum of Technological Knowledge, from complete iPad novices at one end, to teachers with well-established pedagogy having used iPads for years. Each coach's relationship with a particular teacher was crucial in changing his or her pedagogy and helping that teacher to integrate iPads more successfully and more consistently in their classrooms. They helped to increase the TCK (Technological Content Knowledge) of their teacher, regardless of the level of understanding or expertise at which the teacher started. With their regular input, teachers gained experience in using the iPads as well as confidence in using them in the classroom.

The TPCK Model and the Data

The data does seem to validate the TPCK theory. Generally, neither the ed tech coach nor the teacher started with the iPad or Technological Knowledge (TK), or with the topic or Content Knowledge (CK), but from the teacher's Pedagogical Knowledge (PK); two atypical instances are discussed later. The coach would ask, or the teacher state, what they wanted to achieve pedagogically with the iPads; they wanted to increase their Technological Pedagogical Knowledge (TPK), exemplifying 'Category 1: Dependent learning' in the DISA matrix. Next, they discussed into what topic the

teacher wanted to integrate the Technology Content Knowledge (TCK). While seldom explicitly discussed, the end result was always that the Pedagogical Content Knowledge (PCK) changed. It is impossible to influence one aspect of the model without influencing all areas and so developing an individual's TPCK.

Instead of seeing the TPCK model as a neatly fitted together jigsaw model, it may be helpful to consider it in terms of an iterative flow diagram. PK filters through CK and then through TK. Increasing CK does not greatly impact the teacher's PK or TK but is an essential base on which the teacher builds their Pedagogical Technological Knowledge (PTK). It is when PK is applied to TK through CK that the TPCK grows the most. In turn this feeds back into PK and the cycle restarts.

Examples of data instantiating elements of the TPCK model

The discussion begins with an example of the TPCK cycle starting from the teacher's PK. This occurred when Teacher 4 (T4) told Ed Tech Coach 4 (C4) that she was bored with her usual way of teaching Mitosis. C4 suggested that, instead of T4 presenting all the material, she should give paired students a short explanation of what cell division entailed and then the responsibility to create short stop-motion videos of the process. This necessitated C4 helping T4 to download and learn to use a stop-motion app, before requiring the same of the students. The teacher's PK was applied to new TK through her CK, strengthening her TPCK. When the students' work had been assessed, T4 realised that she needed to tweak her pedagogy to give the students more support at the beginning and so adapted the task requirements for the following year:

“(T4) Just so they understand its lots and lots of photos. I think I would also simplify it as well, because we asked them to put text and commentary on the stop-motion, and perhaps that was a little bit too much for them, to expect. So next year what I would do is ask them to do a stop-motion and just include some text which they can do by putting labels on, on their actual little play dough things.”

Atypical instances were brought to the fore in the data from two interviews when neither coach nor teacher started from the teacher's PK. The first took place when C3 demonstrated the Clips apps to T3. As colleagues of eight years, their respectful and trusting friendship enabled C3 to show T3 the app quickly as iPads are well integrated into her teaching making her TPCK well developed. Their discussion revealed how they build on each other's ideas, even finishing the other's sentences. It also raised new pedagogical ways to integrate Clips for T3's students' benefit. T3 was immediately

excited to practice using Clips before she showed her students what to do. Then she suggested a change to her pedagogy by using the app to make a mini-movie for the students about their recent history outing, in other words, using the common experience of the students to develop a relevant, local and contextualized teaching resource. C3 extended this idea in two ways, saying it could be used both as a record and as a way for students to share their learning with their parents. They conclude that there is no need for teachers to tell parents what the students learnt, as students could share their learning directly with their parents. This both validates the students' experience and makes them teachers of their parents:

“(T3) I just want to show them. You know we visited Melville Koppies, so get back all those images and put it in...and play them. (C3) Cause it's a way of documenting things that have happened in your class...Imagine how much fun it is for a parent to come and watch the video Clips of what they've done...and what they've experienced...and let (the students) point out the things that they learnt or they found interesting. It doesn't have to be... (T3) Teacher's stuff.”

In discussing the affordances of using Clips when teaching a difficult section in Geography, T3 contrasted it with the limits of her traditional pedagogy:

“(U)sing Clips will help the girls actually go through the entire (sic) South Africa and see the different land structures and it will be...for the girls real life experiences, something that chalk and talk would not help. Worksheets would not help and I know from previous experiences the girls really battle with understanding (sic) structure of South Africa, the plateau, the Highveld.”

The second atypical instance occurred when the coach started from the teacher's Content Knowledge (CK). In complete contrast to the above example, the coach and teacher were colleagues of five months' standing and C1 helped T1 to use the iPad for the first time. He had no knowledge of how to use it or what it could be used for in his classroom. Although he was a new teacher to the school and exceptionally willing to learn, he was fearful, as his previous school had not required him to use tablets or iPads at all. To ease the transition into an environment in which the technological expectations were very different, and where his students were experienced iPad users, C1 decided to start with what was familiar for him, an aspect of his Pedagogical Content Knowledge (PCK); his Content Knowledge (CK) on the Economic and Management Science (EMS) topic of Circular Flow and his Pedagogical Knowledge (PK) of mind maps. Accordingly, she showed him how to use the Popplet app to create a mind map that his students already knew how to use and that could be shown to them from his iPad

through the Apple TV in his classroom:

“(C1) Right, so now we want to go and we want to do a new Popplet. So...sorry just go in to here, and we’re going to make a new Popple. (T1) Popple? (C1)Popple, ja, it’s called a Popple... (T1) Sorry, a Popple is basically a little mind map, is it?... (C1) So if you want to do a mind map of say, you know, the Circular Flow that you were doing. (T1) You have to put the heading in the middle, okay. (C1) So it’s like a, you know when a mind map is like a spider diagram, and all the boys have this as well, and it can be done on a website if you need.”

T1 quickly grasped the basics of developing a Popplet for Circular Flow and immediately started to make changes to the layout that C1 had set up; he was filtering his CK through his new TK to change his PK, as C1 commented:

“(C1) So it’s making you more mobile. It’s making you more efficient. And then linking to Apple TV, you can walk around the class. So you’re not stuck in the front of the class. So like when you’re doing your mind maps you can be at the back of the class...(T1) Oh, that’s great being able to actually interact with the, the class...Cause you, you stand up at the board...You don’t know what the guys are doing at the back there. (C1) Your role changes...from being the sage on the stage...to a guide on the side. And so you actually can walk around and you can actually get them to actually copy your Popplet as they’re doing it and you can say ‘Hang on a minute, that’s not...’ and you can actually give that 1-on-1 attention.”

The SAMR Model and the Data

The SAMR model is useful in thinking about the integration of iPads into the classroom. Each of the four components are grouped into two categories; Substitution and augmentation deal with the enhancement of teaching through digitized work, while Modification and Redefinition deal with the transformation of teaching through digital work. Puentedura (2014) defines each of the four components of the SAMR model thus:

Substitution acts as a direct tool substitute, with no functional change. Augmentation occurs when ‘tech acts as a direct tool substitute, with functional improvement.’ With Modification ‘tech allows for significant task redesign’ while with Redefinition ‘tech allows for the creation of new tasks, previously inconceivable.’

It may be helpful to consider the SAMR model not as a neatly stacked series of steps that teachers climb to reach the goal of integrating technology into their classrooms, but as a flexible series of building blocks that can be used in any order. All of the blocks will help, but it is the teacher’s experience and confidence that determine which block is suitable for any lesson. As C2 said:

“I know they say that the SAMR model isn’t...a ladder, so you don’t start at S and move up A, M, R. But I do think Substitution is...just the first option that

people do because you can put like paper behind glass as they say...and it's just easy. There's not much thinking required. You're just taking what you normally do and putting it on the iPad...(sighs) As you go deeper in, I mean, it requires a change in pedagogy and I think it's all very well that we're trying to get the teachers to use the iPads, but if they don't have the pedagogy they can't move forward."

The data reveals that teachers move their pedagogy forward most quickly with the help of an ed tech coach.

Examples of data instantiating elements of the SAMR model

These examples are not exhaustive, but intended to convey a range of experiences across different grades.

Substitution

Substitution involves substituting paper documents for digitized ones on the iPad. It is an easy entry for teachers not used to working with iPads as they do not have to redesign their worksheets and the like. It can mean using the iPad as a typewriter. T4 gave a straightforward example of Substitution when she asked her high school students to type up a document on their iPads rather than write it up by hand or type it up on a PC:

"T4 (T)he girls had to write up a document recording...what they had...learnt, in terms of aim, hypothesis, results in their scientific experiment."

T3 asked her students to use the iPad to plan their creative writing; some extended their usage to include writing down homework:

"(T3) The girls have used Word...for their planning when they're writing their stories... I've also had girls using...the app Notes to take down their homework to use it as a digital diary."

T3 also altered her pedagogy by substituting classwork that would have been done on paper for work that was done on the iPad:

"(T3) Very recently in Afrikaans class, the girls had to make a town hall plan with...directions and they used Pages...to make the town hall plan."

T5 altered her pedagogy by substituting her paper worksheet for a digitised one so that a Grade Two student could keep up with the class:

"(T5) I have a child who has a broken arm...and it was his writing hand that he broke, (sighs) so, he's been doing work on the iPad...his creative writing and...spelling tests."

Augmentation

Teachers, who extend their pedagogy by using the iPad to augment their teaching, find themselves and their students using the more powerful word processing functionality allowed by the iPad, so they work in increasingly sophisticated ways. C1 described a simple way in which Augmentation can be demonstrated and gives a benefit for teachers and students around the speed of teacher responses:

“(C1) (T)hey used different fonts. They had to put in a content page...bold...footnote...referencing...a header and a footer. (T)hey type essays...the reason being is that the teachers can then give instant feedback, comments or suggestions.”

C3 spoke of Augmentation as applied to students sharing their own work with themselves and to learning a First Additional Language:

“(C3) So, just recently the Grade 6s used Pages, or any other word processing app, to type up a letter to their buddies, which are the girls that are going to be in Grade 3 next year when they’re in Grade 7, and these were then emailed to their PCs, to their school email addresses, where they printed them to hand to the students. So that was typed up and edited. A lot of them use it in Afrikaans to type up new vocabulary, to add pictures to it, but they are typing up vocabulary.”

C3 also mentioned the benefit of changing the font for students who need extra support:

“(C3) (W)e’ve had children who have used things like dyslexic font, or teachers who’ve used dyslexic font to assist students with reading.”

C4 discussed the synergy that was apparent when the ICT and Geography teachers co-operated:

“(C4) (The ICT teacher) used the ICT lesson to...deliver tools that (students) needed in another topic. So they took the Geography project into account when teaching them the tools in ICT and the mark they got related to both, which I think was...very good.”

C4 gave another example of students using the iPads to display augmented learning. The Peer Mentoring committee is made up of students who help fellow students with their academic work:

“(C4) (The) Peer Mentoring committee, they've gone for a Classroom solution to share past papers, which they are managing themselves.”

C5 discussed teachers changing their pedagogy by allowing students to submit

typed work, with its inclusivity benefits and of students using Augmentation tools to help with studying:

“(C5) Some of the teachers started allowing kids to submit their work...you know...have printed out and then pasted it into their books if...that's the way they wanted to do it, because...some kids' handwriting is just illegible and you can't read it. So for those kids and it was a bit of...an inclusive way of doing things, because if the...kids that weren't able to write properly...or at least legibly...they were still able to submit their work, because a lot of times those kids get left behind, because the teacher can't read what they're saying. (I)f there's like a paragraph section where they needed to highlight...key concepts, they used...the highlighting tools.”

Furthermore, C5 discussed an interesting Augmentation variation that English second language learners appropriated to improve their language skills:

“(C5) (T)hey used it...to actually type the work...before they write it into their books so they can see whether or not there's...that little red line that's...under the writing...so, they can see whether or not they make mistakes...So instead of now just getting through (the work), they actually check what they're doing.”

T2 demonstrated how the iPad augmented both his and his students' work in these two examples:

“(T2) It happens...in terms of airdropping documents...to each other in class, to find that somebody hasn't received a particular email from a teacher in class and then, instead of (laughs) resending it, and then boys will just literally volunteer and say, “Can I airdrop the document?” and then people will shout names, “Me, me, me, me” and then that's how the information (laughs)...gets across and then quickly.”

“(T2) (W)e were looking for isiZulu articles for the school magazine and I've asked boys to type...their creative writing...using Note and then afterwards they emailed that to me as the teacher, and I was able to read, and then proofread, before submitting it to the relevant committee.”

T4 changed her pedagogy and augmented her teaching by giving tasks and rubrics electronically to her students:

“(T4) The tasks are always given electronically to the students so they've always got access to it, so they can refer to it. The rubric is always given to them electronically as well.”

She further discussed how students use the iPad to augment school work:

“(T4 (A) lot of the senior students it helps them organise...their summaries, their notes...access to digital content works very well...(T)hey've used iPads to type up content which has to be submitted electronically for assessment as well.”

Modification

While Modification allows for sharing on a scale unknown in classrooms previously, there is still a need for teachers to mitigate the offerings of their students before they are shared outside of the classroom or school:

“(C1) In English, one of my English teachers has done a whole blogging session the whole year, but she’s moderated it, and she’s only made it (available to the general) public when she’s comfortable with what they’re putting there.”

She talks about a more conventional way in which Modification changes pedagogy:

“(C1) So at the moment we’re using Flipgrid a little bit, which is a video sharing tool. So it sets it up in a grid and the children can actually give the answers, or their feedback to something on, um, tch, on any topic and it can be shared with the class (who)...can actually comment on it and make suggestions. So there’re lots of ideas we can share digitally.”

C1 continues with another way in which teachers used Modification to allow for students to build on their research skills to develop new presentation skills:

“(C1) (W)e looked at the end of World War I, so we looked at...the treaties...so it was extension...(T)he boys had to each go and research it. They had to find text, videos, images, and then again put together...an infographic on the information.”

C3 builds on this theme of new material and new presentation skills in detailing how First Additional Language teachers modified their teaching to assess different competencies and let students share their work with other students in the school. As the students chose their own ten words, a much wider range of vocabulary items were presented to the other students than would have been the case if the teacher had given all of them the same set of words:

“(C3) (A) group of Grade 5 girls were using school owned iPads at the time, (coughs) to create mini dictionaries for their first additional language subjects. They had to pick 10 words and then they had to make sure they spelled them correctly. Then they had to source their own photographs...to illustrate those words. They put them into Book Creator and then they had to pronounce the words and save the pronunciation of the word and then put it in a sentence. So they created sort of digital multi-touch dictionaries and these dictionaries were then used...to assess the pronunciation, their understanding of the words, as well as the actual look at the book, and then those books were shared with other students. So other students came in and had a look at them, so it became an authentic learning tool for other students.”

T2 used the increased functionality to modify his First Additional Language teaching through allowing students to reflect on their work and make changes before resubmitting it:

“(T2) (W)e’ve used it to edit it and rerecord and rewrite our dialogues.”

T4 gives an example of using the iPad to modify the work done in class in a simple way, where they used their devices for research:

“(T4) (W)hen we’re introducing a topic and I ask the girls a question and...I see that they don't know the answer, for example...what is a tissue...I get them to go onto their devices and find an appropriate definition. So that could just be ad hoc in class or it could be a more formal assignment as in the assignment that I gave the example in, in, with the Grade 8s doing that classification work”

T5 recounts how her young students watch, for inspiration and pleasure, the cartoon videos created by other young students:

“(T5) Then some of them love using Toontastic. Then they go to old videos that the children have created and...watch it through there.”

Redefinition

C1 details a delightful take on Redefinition, where the time, money, and personnel constraints made the students focus on the essentials of the task:

“(C1) Well, we did sweded movies in Drama. So ‘sweded movie’ was from...a movie that was called...Rewind...(A) guy that was working in a video shop, burnt down the video shop, and his boss gave him one night to recreate every single video with no budget. So we took the children through the steps and they had to take their favourite...movie and they had to put together a Clip using their iPads without any budget, so we had toys, etc. They had a ball. They learnt about...directors and editors, so it was a...very wide ranging project.”

C2 articulates how students presented their learning in a movie trailer after having done extensive background work in a rich task. In summing up the character students gave voice to both facts and opinions with the trailer acting as both process and goal:

“(C2) (W)e have done...English work where boys had to first study character, and settings and...had to understand emotions and all that kind of stuff...It was a lot of work that went in before...they got to put all that learning into a short...trailer...which the boys absolutely loved and I think working through all the worksheets was easier because they knew what the end product was that they were working towards...I know with the IBL (Inquiry Based Learning) as well, with the Grade 4s...I do feel that we wouldn't have had as much success...if we didn't use the iPad because...the content was just available...when we had our

day off to create our project. I mean they were doing Keynotes, Power Points, digital posters, filming...and creating movies and I think that they gained SO much out of that besides just regurgitating the research...their character came through and...their opinions and that kind of stuff."

A different take on applying the concept of Redefinition is spelt out by C3:

"(C3) (W)e had an activity in the library where the girls created their own video book reviews and they were linked to QR (Quick Response) codes and Aurasma (an Augmented Reality app) triggers which were then placed temporarily on the books, so...it created an excitement, getting kids back into reading. And there is no way that you could've done that without an iPad because, not only to create the content, but then to access it afterwards, because you had to be able to scan the QR code, or scan the Aurasma trigger image, to be able to view that work, and that could not have been done without the iPad."

C4 gave examples from different departments and grades, each revealing individual perspectives on what redefined teaching can accomplish:

"(C4) The Grade 11s did...an Afrikaans advert where they had to film and do voice overs and whatever...the Grade 10 Stop Motion project...the Grade 8s did a Drama activity where they did a make-up tutorial they had to record...interviews. I think that was English and Drama, where...some of them actually used green screen...Grade 9 they did a Geography project with the weather. Also the infographics. We had one child...in matric, she was (doing) an LO project. And we actually had to say to her, "There are such amazing tools. What are you doing trying to do this by hand?" She said, "No" she wanted to draw it. We said, "No, you don't" (laughs). "You don't have time for matric LO to be drawing this!"

Even the younger students redefined their learning:

"(C5) (A)t the (junior school), with iMovie, the kids (talked)...about certain things that they've done, um, as, almost as a news report, and then they used iTunesU to cut together this, the different segments of where they had to interview...each other...and cut together those different segments...using iTunesU and the Bulletin Report. (T)he Grade 2s...were the ones that did it. They enjoyed it immensely."

One of the most successful ways for iPads to be integrated through Redefinition occurs when teachers set up iTunesU courses. All teaching resources are put into the course. Once these have been downloaded, students can work offline. Google Classroom does not allow this and it is a major saving on IT costs for the school and the home. Students work through the course at the pace decided by the teacher. It can be either teacher-paced or student-paced. All work is done through the course and also

submitted through it. The teacher is notified when material has been submitted by a student and can assess it immediately or later, with options for written or spoken comments. All students have access to all the material in one place, so there is no opportunity for work to be lost, or wrongly filed, or not submitted. It also means that students have the material to hand for study or revision purposes. T3 highlights a benefit for teachers and students if a student is away from school, whether through travel, sport or illness:

“(T3) Whenever a child is absent...I would email the girl and tell her (to)...please look at the iTunesU course and don't forget to finish and if you have time, if you're not feeling...too...unwell, you can complete the certain task...All the Maths...if it's a worksheet, I scan it through and email it directly to the child. The child will then open it...open it up in PDF Expert, she'll complete it and then hand it in. So learning continues and...remediation from my side also continues and then the child doesn't miss out...Obviously with me the girls submit their works via iTunesU or...they use PDF Expert and either save it on the student drive that I can access or they can email it to me. We also have...girls where they can AirDrop their iMovies. They can AirDrop...their Keynote presentations to me so that's how they share...it digitally with me and with the wider audience and myself. We've also had girls posting their iMovies onto YouTube...where access is given to...the rest (the girls' primary).”

Similarly, T4 communicates how iPads are used as all-in-one devices in her subject. As all work is date and time stamped, if students do not submit work by the stipulated time, it is easy for the teacher to see this. There is no opportunity for students to lie. Furthermore, teachers do not have to print and reprint work, saving on printing and photocopying costs:

“(T4) (W)e give the students a lot of tasks where they have to use...their iPad to...compile their work and submit it...and it's not an option to do it in written form. They have to use the iPad to submit that work.”

Conclusion

The earlier examples have shown a justification for the vigour of the TPACK model, especially when ed tech coaches help teachers with the specifics of integrating technology into their classrooms. Similarly, the later examples strengthen the role the SAMR model plays in framing broad building blocks that teachers can use to significantly change their PK in order to develop their TPACK when integrating technology. This leads to students doing very different tasks when they use iPads. At the simplest level, Substitution allows for teachers and students to work offline wherever

they find themselves. Teaching and learning becomes ubiquitous, flexible and mobile. Augmentation gives opportunity for faster and more convenient communication between teachers and students. It also permits a more sophisticated presentation of work than handwriting on paper would allow. Students quickly use tools such as boldface, centring, font changes, indentation, highlighting, borders, content tables, headers and footers. This helps them to think about their content and its presentation in the same way that adults do in their working lives. Modification changes how students think about their work as they have greater control over it. They also need to work with an audience, not only their teacher, in mind, whether this is composed of peers, friends, family or strangers. If their work is part of a larger piece of work done by the class, they need to tailor their individual contribution to fit in with that done by the others. Redefinition changes teachers' and students' school experience completely. It allows for a greater degree of student independence when teachers are confident enough to trust students to create some of their own learning materials and it frees the teacher to offer one-on-one remediation when and where it is needed. Instead of students feeling abandoned by this responsibility, many of the teachers reported significantly more communication with their students when it was done electronically.

When ed tech coaches use the building blocks of the SAMR model to develop the PK or TK through the CK of their teachers, they strengthen their TPACK. This results in both teachers and students working in different ways. A mobile device on which work can be done online or offline enables teachers and students to teach and learn with ubiquity, flexibility and sophistication, especially with increased and speedier communication. More importantly, teachers can offer extension and remediation when needed and students can work with greater confidence, independence and control over the process and product of their work. In summary, it could be concluded that ed tech coaches mediate the integration of technology to enable teachers to realise the educational affordances of iPads in their classrooms.

Finally, with a detailed understanding of the conceptual framework, the literature review, the methodology and the instantiating links between the TPACK and SAMR models and the data, the analysis and discussion of the data is presented. It is crystallised into a finely wrought portrait of an ed tech coach which is now presented.

CHAPTER 5: PORTRAIT OF AN EDUCATIONAL TECHNOLOGY COACH

This portrait of the focus areas of a successful ed tech coach is an agglomeration of the described practices of the five coaches in the study. These descriptions do not necessarily apply to all of them, although often they do. The quotations given are those that best exemplify the attributes under discussion, without listing how each coach exemplified the feature under consideration, unless it adds new information. Later, the descriptions will crystallise into theoretical generalisations and an emerging model of an ed tech coach.

Backgrounds of the Ed Tech Coaches

The ETCs displayed remarkable similarity in their approach to helping teachers integrate iPads into their teaching. They were all experienced teachers with strong IT skills; three were IT specialists who went into teaching, two were classroom teachers who developed their personal interest in IT and fed it into their teaching. Two were Apple Distinguished Educators (ADEs). All of them started with PCs and Windows, then moved to iPads and iOS, often working in both environments during the school day. Four were appointed as ETCs, not as IT teachers or IT support personnel. The unique situation of the fifth, ETC5, who is both an ETC and an IT teacher, is discussed later. Frustratingly, staff members sometimes still request their help with IT issues, even though there are dedicated IT personnel on site. Having to perform as an ETC and an IT engineer creates time pressures that dilute their effectiveness. The time they spend resolving IT issues, often as simple as reconnecting to the Wi-Fi, also does not help the teachers develop confidence in their own problem-solving abilities. Generally though, those teachers who commit to regular sessions with an ETC start to resolve their own IT issues.

None of the ETCs were given a job description when they were appointed, beyond instructions to help teachers integrate technology into their teaching, nor was there a curriculum they could implement, as this was a new field of endeavour for South African education. They all began with what the teacher wanted to achieve. The teacher's pedagogic agenda became their agenda. While the junior school ETC informally asked his teachers if they "would want to use an iPad in their class and how (were) they going to use it?" the two high school coaches surveyed their colleagues to discover what they

wanted to achieve. This is especially important, as high school teachers are subject teachers and not class teachers as junior school and primary school teachers generally are. If an ETC helps a class teacher then iPad integration will happen across the different content lessons, but with high school subject teachers the integration will occur across the various grades they teach. Whether integration occurs across subjects or grades is less relevant than the manner in which ETCs work with teachers. To this end, the following method of analysis of the interview and observation transcripts was undertaken.

Method of Transcript Analysis

First, each school, ed tech coach and teacher were given the same number used to denote all three. They were labelled chronologically as shown in Table 3 below based on the age of the school, with the oldest school, the boys' high school, being given the number 1, while the newest school, the junior school, was given number 5.

Table 3: The school, ed tech coach and teacher numbering system

School, Ed Tech Coach and Teacher	Number
Boys' high school	1
Boys' primary school	2
Girls' primary school	3
Girls' high school	4
Junior school	5

The librarian of the oldest school, the boys' high school, had allocated these numbers to the different schools when they were constituted, to differentiate amongst them for cataloguing purposes as the five schools share one common library catalogue rather than five separate ones. As the girls' high school librarian, the researcher had worked with this system for eight years and chose to keep to this familiar pattern.

The transcripts were divided into five groups. The researcher read and analysed the transcripts in group-order and within each group the researcher read the transcripts in sequential number order as set out in Table 4 below:

Table 4: The order of transcript analysis

GROUP ORDER	ORDER WITHIN GROUP
Coaches' background interviews	1-5
Teachers' background interviews	1-5
Coaches' specific interviews	1-5
Teachers' specific interviews	2-5 (no specific interview with boys' high school teacher)
Coach and teacher observations	1-4 (no specific interview with Junior school coach and teacher)

The background interview with the boys' high school ed tech coach was analysed first, followed by that of the boys' primary school ed tech coach and so on. The transcript of the girls' high school's coach and teacher observation was analysed last.

As I had done all the interviewing, recording and transcribing, I was very familiar with the content of the interviews and observations. Over the eight months of collecting the data I had time to mull over that already collected and think about what it revealed about how a coach worked with a teacher. It also gave me time to mentally compare and contrast the different styles and approaches the coaches used in dealing with their teachers.

When it came to the analysis, I started by reading the background interview with coach 1, highlighting salient points and making notes in the margins of the transcript, typing these up into a separate document. Then the categories, such as 'The teacher's needs and timetable', 'ETC availability' and 'Approaching teachers', were drawn up and added to the notes document. Next, I wrote up the points under these categories, giving an example for each from coach 1, as the basic framework for the Portrait of an Ed Tech Coach. Later points from each interview and observation added depth to the framework. Sometimes the framework was adapted and the categories were re-organised to accommodate later points more logically. Those categories that naturally formed part of a larger category were put together, so the three categories mentioned above were put into the larger category of 'Teacher-driven Scheduling'. When the transcript for the background interview for coach 1 was completed, I then analysed the transcript for the background interview for coach 2 and so on until all the interviews and then the observations had been analysed.

This study was an investigation into how the approaches ETCs adopted for helping teachers revealed some of the focus areas of a successful ETC. The data suggested the following six focus areas: Teacher Driven Scheduling; Relationships with Teachers; ETC-driven Agendas; Teacher-driven Agendas; Learning from Others and Personal Professional Development. It concludes with a proposal of An Emerging Model of an Ed Tech Coach. The six focus areas are now discussed, with detailed reference to the salient points and notes made on the transcripts. The naming convention used to indicate which transcript a comment came from is given in Table 5 below:

Table 5: Naming convention for comments from transcripts

CONVENTION	MEANING
R	Researcher
ETC or C	Ed Tech Coach
T	Teacher
b	Background interview
s	Specific interview
o	Observation

The following examples elucidate how the system was used: ETC1(b) refers to the ed tech coach (ETC) in the boys' high school's (1) background interview (b); T2(s) refers to the teacher (T) in the boys' primary school's (2) specific interview (s). For comments from the observations, each participant is referred to individually, so ETC3(o) refers to comments made by the ed tech coach (ETC) in the girls' primary school (3) during the observation (o), while T3(o) refers to comments made by the teacher in girls' primary school during the same observation (o). With all this background information in place, attention now turns to the focus areas of a successful ed tech coach.

Teacher-driven Scheduling

Before any coaching is undertaken, the coach should be cognizant of the teacher's schedule as this impacts when and for how long they can meet.

The teacher's needs and timetable

Firstly, the ETCs set up meetings according to the teacher's needs and timetable. As they had worked in schools themselves for an extended number of years, they understood the demands placed on teachers by dynamic forces prevalent in the classroom, one of the most important of which is timetabling. Teachers' timetables are not easily overruled and teachers guard both academic time with students and their own administration time, but this sometimes has to make way for play practice, substitution or workshop attendance. T4(b) noted a "big problem we face using technology...is time for teachers to go and experiment and prepare lessons." Allied to having "a set syllabus to cover...(and) time in the classroom" was the need to negotiate the new timetable the girls' high school had implemented at the beginning of the year in which some subjects now had two-hour long lessons for senior students. Restrictions such as these necessitate the ETC being flexible with their timetabling and rescheduling

meeting times as required by the teacher. In a rare instance of a coach meeting with more than one teacher, T3(b) and her Grade 5 team met with ETC3 during the school day “initially...two times a week and...as we became more confident...we met with her less. However, there are times where we actually met with her VERY frequently, almost every day.” This was at the start of their implementation of iTunes U courses. She relays that they also met “over the holiday, over weekends” and that she appreciated that ETC3 made herself available to meet at their convenience. Their meetings ranged from “half-an-hour... (to) five to six hours” depending on whether they met at school or at ETC3’s home. In this respect ETC3 was different to the other ETCs who maintained more formal times with their teachers. In contrast, T4 (b) met “with (ETC4) on an ad hoc basis. So when I (needed) some assistance...I send her an email...or it it’s just a quick question, I just pop past her desk.” These meetings were entirely driven by the needs of the teacher and her department.

ETC availability

T4 (b) introduced ETC availability as another aspect of teacher-driven scheduling for help during class time: “I like the fact that I can book her ahead, in advance.” This enables ETC4 to come into a specific lesson “just to check that the girls are on the right track, or to give them some technical advice.” T4 (b) found it was “really helpful to have an Ed Tech Coach that doesn’t have any classes to teach, so she is quite freely available.” In stark contrast to this, the previous ETC had had little scheduled time to help teachers as she taught Computer Applications Technology, ran the school’s administrative system, and was doing her Honours degree. Unsurprisingly, when she took a position elsewhere, the job was split between two new staff members, so ETC4 now only is responsible for helping staff and students integrate technology. T4 (b) felt her availability “made an immense difference to using technology this year.” Having a dedicated ETC seems to enable technology to be integrated more thoroughly and more speedily.

Approaching teachers

The ETCs know when a teacher needs more help. ETC4(b) mentioned that T4 is aware of one department member “who’s very nervous of technology and T4 has asked me to spend more time with her...not even necessarily on the project work...(but) more in terms of getting her comfortable using her iPad.” Conversely, they also know when to

leave teachers alone. ETC2 (b) observed, “with other teachers...I have held their hand a lot more. And I think with T2 I’ve sort of just given him that intro and hopefully let him fly.” ETC1 (b) remarked on a different reason for staff discontinuing meeting with her when she commented, “I’ve got...people that come the whole time. I’ve got other people that help one another now that they don’t actually need to come to me.” This was echoed by ETC3 (b), “She has now become someone who is showing others how to do things.” This form of peer teaching, which could also be called the multiplier effect, is a strong indicator of the high level of trust that has developed between an ETC and teacher as the teacher begins to take on part of the ETC’s role. It is also a powerful indicator that the coach’s teaching is starting to gain traction amongst the staff.

In summary, a major limitation for any teacher is the amount of time he or she has available during working hours to spend with the ETC who is entirely subject to the timetabling constraints of the teacher. Teaching time, marking, extra murals and the school’s wider needs trump an individual teacher’s scheduling of meetings with the ETC. However, the data seems to indicate that teachers are more willing to spend time with an ETC, both during school time and, in some cases, outside of school hours, when they trust the coach. This leads to a discussion of the second focus area, that of the relationship an ed tech coach has with a teacher.

Ed Tech Coaches’ Relationships with Teachers

Unusually, T4 was part of the interview panel for a new ed tech coach before ETC4 was appointed. The interview included a lesson demonstration in which the panel members were invited to participate as ‘students’. T4(b) made two points about the interview: “She was very much hands-on...She was very quiet, so...nobody needed to feel stress, so I really like that about her.” This calm spirit and the desire to work with the teachers in a practical manner would seem to be positively connected to the development of a trusting relationship between coach and teacher and possibly be a predictor for the success an ed tech coach could achieve. This could also speak to the validity of the research process as coaches and teachers assessed their relationship and practices within the school context as mentioned was desirable in the chapter on methodology. Their close relationship is emblematic of the deep levels of trust and engagement both parties seem to have developed.

Feedback from teachers

Working practically with teachers is dependent on the feedback teachers are prepared to

give ETCs. ETC4(o)'s opening words to T4 were "Your project, first, how's that going?" This immediately brought the ETC up to date with the progress T4 had been making and gave T4 an opportunity to bring out both positives and negatives of the app implementation she had done. T4(b) summarised her feedback as "Mainly how the kids reacted...and it was more problems than anything else that I asked her." It is safe to deduce from this that previously ETC4 and T4 fully discussed all that T4 needed to do in class before the lesson and that she implemented this teaching as far as she was able to with her students. This meant that afterwards T4 was able to ask for the specific help she and her students found they needed in that lesson. In discussing a new way to use an app the teacher had some familiarity with, ETC2(o) asked T2 "Do you know how to get images?" His honest reply 'No, I don't,'" enabled ETC2 to teach him a basic skill needed for him to extend his changing pedagogy. It appears that starting a coaching session with teacher feedback could provide a targeted entry point for an ETC to listen respectfully to what the teacher wants to communicate and to work at the teacher's pace.

Feedback from teachers who have taught with iPads for some time appears to focus on implementation rather than integration. T4(o) initiated a discussion: "There was something else I wanted to ask about. It's like a technical issue actually." This is indicative of T4's confidence in ETC4's ability to frame what another person might construe as failure rather as a learning growth point and of her ability to resolve the issue satisfactorily. If a teacher is willing to admit to a sense of failure in front of a relative stranger, in this case the researcher, this might be considered as revealing the deep trust between the coach and the teacher. The teacher seems to be confident that the ETC will resolve her difficulty and that she will be able to learn from this irrespective of the presence of another person. At the end of their time together, T4(o) checked that she had asked all the questions she wanted to: "I've worked out all my little glitches...We've worked that out." Her high levels of organisation were contributing factors to her successful iPad implementation. It also looks as though the mutual trust and respect between the coach and teacher could have created a safe environment in which all questions and problems were seen as valuable paths to a teacher's confident implementation of specific iPad apps.

There may be times when a coach discovers an app that could be useful to the teacher. ETC4(o) mentioned the Plantnet app: "You take a picture of a plant and it tries to identify it for you." Unfortunately it was not appropriate for South African plants as the

“databases are American.” Although T4 was interested in ETC4’s thought of building “up our own internal database,” they both realised such a project was beyond the limited time available to a high school teacher. However, this short discussion opens an intriguing possibility that such a database, or even the development of an app, could result from collaboration between a coach and teacher.

Sometimes feedback points to the assumptions ETCs and teachers made which caused problems for students. T4(b) mentioned “It was quite a disappointing set of results that (we) got from the Grade 8s...the girls hadn’t actually read the instructions properly, typical Grade 8.” She judged this was because “we put the instructions onto Google Classroom.” In future she felt it would be better to give the girls “a hard copy...so they can tick off as they do stuff. And the teacher can explain in detail...just to make sure that they keep on track.” This may point to the need for ETCs and teachers to take into account the students’ inexperience in working entirely digitally and to manage this process more slowly.

T4(b) gave another example of an assumption she and ETC4 made in the stop-motion task given to the Grade 10s. “My biggest error was in... (not giving) them enough technical information beforehand.” She had not emphasised the number of photos needed for one second of stop-motion. The girls “really had to drag out the (movie) to make it the (specified) length of time and so it lost its impact.” Although she knew the girls had learnt, “we would have had nicer presentations and the girls would have felt better about their presentations” if they had had a greater number of photos. The girls also had not read the Google Classroom instructions, so in the following year T4(b) would show them “an example of a stop-motion...and give them some technical detail.” She would also simplify the task and give the girls less time to set up before they start taking photos as some of them are distracted by their need for perfectionism. It would appear as though a prime benefit of a coach meeting individually with a teacher is the opportunity to discuss even small issues that could negatively impact on the integration of iPads and apps.

Individual meetings

The evidence suggested that all the ETCs eschewed whole staff or whole department teaching as the standard format for professional development. Their comments in the interviews emphasise a preference to meet individually with teachers to ensure they

both knew how to integrate apps practically and when to implement apps appropriately. This type of interaction seems to have enabled them to focus fully on what a specific teacher wanted and made it easier for the ETC to help the teacher answer all the questions he or she had. As ETC1(b) said, “I prefer one-on-one training. With big groups you risk losing the person that knows nothing and boring the person that knows too much. It is very time-consuming.” There was a noticeable tendency to consider the benefit of helping teachers individually as worth the time cost. In effect, they can be understood to be slowly developing IT champions who would become multipliers and through peer teaching help iPad integration to spread throughout the staff, as teachers spend more time with their colleagues than an ETC does. For example, ETC4(b) found that her head of department teacher had “really engaged and seen the benefit of (iPad integration) and pulled it through her department.” This combination of flexible scheduling and spending time investing in individuals to develop them as champions seems to have led to two successful outcomes.

The first successful outcome was made plain by ETC4(b), who was elated when another staff member from her champion’s department came “into the office, without anything scheduled, to come and say, ‘I’ve tried this, it worked (or) it didn’t work. Look at this.’ That’s when they’re excited about the technology.” The teacher appears to have been emboldened to implement something on her own, without prior consultation or targeted help. She could have identified a way in which the iPad could change her pedagogy and was confident enough to try it on her own. ETC3(b) clarified that such confidence did not mean the teacher felt unable to ask for help later as her experience expanded. “She’s become an innovator in her own right. She tries new things without asking for permission and without necessarily seeking assistance with it, but at the same time she’s not afraid to ask for help.” “For the last three years” this T3(b) had had teachers from schools in other provinces “coming and observing my lessons, beside my mentors...to see whether the iPad is successful and how we are actually using it in class as a tool to enhance learning.” She helped her students, her Grade 5 team, her school colleagues, and presented at meetings outside of school. In her words, “I think what sets us apart is the fact that we have this cutting edge technology and...are motivated to stretch ourselves in terms of using technology...I think what ETC3 has done is put us on the map.” She was encouraged to expand her role from being a class teacher and grade

head to teaching other teachers. It seems to suggest that she had become an ed tech coach in her own right and that her behaviour was modelling the vision the school had for teachers and that she was marketing the school brand effectively. It could also be seen as affirmation of the work ETC3 was doing, as another hallmark of her success. This idea is discussed in the Conclusion.

Obviously an ETC would continue to develop teachers who have extensively integrated iPads into their classrooms as well as those they have not helped individually before. ETC4(b) happily observed, “for the first time (I’ve) had (another) one of the department people approach me for a project.” At other times, she says, “I will have a teacher saying to me, ‘Oh, I saw you doing that with X...can you show it to me?’” These unsolicited requests appear to affirm that her friendly, calm and non-threatening approach did develop trusting relationships with teachers even though they had not had much contact outside of occasional and brief departmental meetings.

ETC1(b), who revealed that staff had one of two reactions when asked to implement iPads in their classrooms, noted the second successful outcome. Those viewing it negatively felt “stressed (and) some staff (wanted to) withdraw,” while those viewing it positively said “I want to try.” T3(b) “had a positive mind and...wanted to learn...and found ETC3 to be very approachable.” For ETCs to work successfully with both technophobes and technophiles the evidence would seem to confirm that they should have a positive relationship with all teachers and be someone teachers could relate to confidently.

Relationships based on trust

This notion of developing teacher confidence in using iPads is rooted in the relationship a coach develops with a teacher. Several times teachers mentioned that their good relationship with the coach is embedded in trust, which could enable them to feel safe enough to ask for help or explanations more than once. As T1 put it to ETC1(b), “I know you explained this to me last week, but...I need you to go over it again.” ETC1(0) reiterated to T1 that I “will take you through step by step...I’ll never throw you in the deep end.” She was happy to go slowly, at the pace he would learn most effectively. T3(b) was adamant that “the support from ETC3 was paramount, to myself and the rest of my team, because this actually stretched the band and help (sic) us actually really be as creative in class.” Comments such as these indicate that there may be a link between a teacher feeling secure that his or her lack of knowledge or experience will not be

exposed in a way that renders him or her ineffective as a teacher and the ability to integrate iPads competently.

The excellent relationship between ETC3 and T3 allowed them to build on each other's ideas. While ETC3 was demonstrating Clips, T3(o) remarked, "We're doing early African farmers now...You know we visited Melville Koppies, so get back all those images and put it in and play them." ETC3(o) took the discussion further, "Cause it's a way of documenting things that have happened in your class." She took the implementation to another level through suggesting "Imagine how much fun it is for a parent to come and watch the video Clips of what you've done....and let (the girls) point out the things that they learnt or they found interesting." The preponderance of data may indicate a connection between the coach wanting the teacher to succeed and not pressurising the teacher to behave in a certain way and to move forward only when they are comfortable implementing a course of action. This leads to the coach working at the teacher's pace.

Working at the teacher's pace

Working at the teacher's pace for ETC2(s) meant starting where the teacher wanted to start. "We are doing more content specific (rather than multifunctional or creative apps) because our teachers are still learning. Our teachers are very new in the journey compared to other schools." ETC2 did not force her views onto her teachers, as she knew they would withdraw.

T3(b) reveals that ETC3 used an approach more aligned with that of a flipped classroom: "Something was introduced, I research (sic), I went back and asked questions, things were explained to me...and it was a whole lot of guidance." After this, ETC3 encouraged her teachers to "go and play. The only way to learn is if you play and you figure it out." ETC3 was cognizant of the fear her teachers had, especially as T3(b) noted "technology is scary if you've never been exposed to it or you're not aware of how to use (it)." However, "once you get into it when you play around, you actually realise it's so simple...you can learn it so easily." She concludes "it's just getting over that fear because everyone can learn." She sums it up as a two-way street that both ETCs and teachers need to walk together: "You've got to...be willing to learn. With anything you've got to have somebody who's willing to hold your hand." T3(o) subscribed to this approach. After she had been introduced to the Clips app, she informed

ETC3 “I am going to play with it and I am going to show you exactly what I’ve done...I think doing something or tomorrow will be...a bit too rushed.”

This points to coaches encouraging teachers to take some responsibility for their own TK development. As T4(o) remarked:

“I found just from that iPad Summit...the things that I remember the most are the ones...where we actually had to do something...these are the skills that we need. This is how we have to set it up. Is it possible for the girls?...How are we going to adapt it?...And to get the teachers exposed to the possibility of what the girls can do, we actually need to get them to do it themselves.”

This idea of learning about technology by using it is discussed at length under ‘Ed Tech Coaches Relationships with Students: Allowing students to learn by doing. The approach an ETC adopts in this regards is dependent on their knowledge of their teachers and what they can do technologically. It may be that the teacher discovering how to use a specific function of an iPad or an app might mark a turning point in his or her relationship with the coach. Whether through deliberate exploration or serendipitous discovery it is likely that the teacher will gain in confidence and competence.

Very occasionally, and in particular circumstances, an ETC can compel teachers to become more technologically confident. ETC3(s) approached a long-standing colleague, and the Grade 5 Co-ordinator, to suggest iTunes U courses as the preferred method of instruction to the other two Grade 5 teachers. She and the ETC had started their iPad journey at a similar time and she already used iPads extensively in her teaching, ensuring that her TK was particularly well developed and her levels of comfort and confidence in using the device was particularly high, making her an iPad champion within the school. When ETC3 began the training with all three of them, the other two teachers were resistant and fearful to the point of breaking down emotionally in the library office in front of the researcher. However, when the ETC showed them how to scan their current teaching material and upload these documents, they calmed down. She encouraged one teacher to upload her map work documents as “that’s where she was comfortable and it was the least amount of work for her.” After teaching this way for a few weeks, the ETC asked this teacher to reflect on her course as though she were a student working through it. Shortly thereafter the teacher commented to the ETC “Why am I (uploading)...my old black and white photographs when I could send them straight to Google maps?” ETC3(s) considers this Aha! moment not as evidence of integration but of something deeper. “I do it because I can, because it’s possible, not because I

have to think about it, because it's just possible." This could be interpreted as evidence of radical change in the teacher's pedagogy because of her technological confidence.

Giving some control to students

When the ETC models this control-delegation behaviour by allowing the teacher to choose which app suits them or their content or the task, this makes it easier for the teacher to model the same behaviour for the students. This could be phrased as the ETC's confidence in the teacher permitting the teacher to experience how the students might react in the same situation and the teacher then giving the same independence to the students.

Students taking responsibility

Firstly, as the teacher becomes more technologically confident, the ETC can support the teacher in giving control of certain activities to students, with the aim of students taking responsibility for their learning and becoming lifelong learners. ETC1(s) rejects an app-based approach: "we look at what our learning is and what we want our learning to be and then we actually advise the children what sort of apps they could use but we allow them to take their choices." Similarly, T4 approached ETC4: "Listen, this is what we want the girls to do. This is the outcome. What are the possible apps that they can use?" She continued: "The girls don't have to use a particular application in order to do their presentation, or in order to do their work." Both teacher and ETC put content and pedagogy before technology. ETC4(s) follows the same principle. She was intrigued when some students choose to combine two different activities for an English project on the novel *Private Peaceful*. "There were some interesting combinations where they'd made a (cardboard) poster and then (filmed) themselves talking about the poster, which I found unusual." T2(s) revealed another unusual use of an app. He had instructed his boys to choose how to present a telephone conversation, of their own making, in isiZulu. Some of his students used PowerPoint, while some made videos with subtitles and voice-overs. However, two boys asked to do things slightly differently with sock puppets: "They just brought their own socks and things...and they had somebody recording them...and then we had to view that in class." The teacher gave control to the students as to how they presented their dialogue. The students came up with their own physical (non-digital) idea but then had it digitally recorded. They were willing to be flexible and creative and use more than one type of technology to get their message across. These latter examples possibly reveal that students do not feel bound to use

only one type of technology (iPad) over another (cardboard or sock puppets), but that they have the creativity, confidence and mental flexibility to use what they have at their disposal. Using iMovie is especially beneficial for junior school students who cannot yet type. ETC5(s) taught his Grade 2 students to video interview each other, then edit and submit their iMovie. "The kids had to talk...almost as a news report, and then they...cut together...the different segments...they enjoyed it immensely." These young students were able to create something that accurately reflected their intellectual ability with ease. These examples appear to be a compelling argument for forms of assessment that are different to the traditional pen and paper ones. When the ETC models this behaviour by allowing the teacher to choose which app suits them or their content or the task, they might make it easier for the teacher to model the same behaviour for the students. It could be argued that the ETC's confidence in the teacher permits the teacher to experience how the students might react in the same situation and give them the same independence.

Students teaching students

A second advantage of giving some control to the students was articulated by ETC1(s): "our children are very good at teaching one another in class. They like to help one another." Furthermore, she articulates that students "like to put their own personal stamp on it...they want to come and say 'This is how I want to do it' and...they sometimes come up with different ways as well." ETC2(s) fleshes this out: "They even found some...different stuff that I'd never seen before with Barack Obama doing dabs (laughs)...so if you just leave them they actually find the stuff. We don't normally always have to tell them what to use." ETC(2) relied on peer teaching to take work forward in one of her extramurals. A new intake of boys into her Lego robotics class led ETC2(s) to try this. "Those new boys I can't spend time with them like I did originally so I've just expect (sic) the boys to teach the other boys." This could be characterised as student-empowerment through their paying homage to the original work the ETC did with them. Similarly, ETC4(s) showed her Grade 8 Web Rangers how to create a badge using Google Drawing, ensuring there was at least one Web Ranger in each Grade 8 class. One of the girls "stood up and gave (the class) a lesson on Google Drawing before they started the app...So they consciously teach each other, but they are always helping each other." Again this seems to corroborate earlier evidence of students deliberately taking on the coach or teacher's role, revealing the high level of co-operation

between the ETC, teacher and student. This idea of peer teaching is developed later on.

Student creativity

In the third place, it would appear that creativity is an important result of student control. ETC4(s) gave an example of her older daughter “using a very relevant app that not many people thought of” for her presentation on de Bono’s hat thinking. She continued that this can be “dependent on how brave the teacher or pupil is.” It does seem that different coaches and teachers have witnessed students wanting to present their work their way. It would also substantiate the idea when coaches or teachers are prescriptive that this can stifle student creativity and lessen their learning, while giving students power over their work and its presentation can boost both.

Student metacognition

Fourthly, ETC4(s) drew attention to an important reason to allow students some control, especially through the use of multi-functional or open-ended apps. “My favourite there is Explain Everything because it really allows so many different ways that the children can talk about their metacognition. They can really think about their thinking.” ETC5(s) is of the same opinion: “Basically it’s a drawing board...they have to put in their own content, they have to do their own mind maps.” He contends that this results in students needing “to sort of think on their own, ‘How am I going to put this together to make it make sense?’” While teachers want their students to learn the content they teach, they also want them to learn how to think about their thinking through that content. If metacognition can be difficult to teach on its own, this would demonstrate that using apps such as Explain Everything could assist with this through providing a context in which it could be developed.

Students doing more than expected

ETC4(s) continued, fifthly, that when students were asked to make an infographic, “there were a couple of girls who went and put in dynamic elements into there, which is way beyond the brief and not expected....they really had fun and produced outstanding work.” When students feel they have some control, they might contribute more than is expected of them. They might work not to please the teacher or to get marks but because they choose to spend more time and effort on a task they considered interesting, challenging or absorbing. This can be significant because they are taking ownership of their learning and seem to realise the inadequacy of passive or rote

learning. They might see themselves as co-creators of the content and co-constructors of meaning. When they choose to go beyond the brief and rubric this can lead to student buy-in.

Student buy-in

This element of fun, sixthly, can contribute to student buy-in into a lesson. ETC4(s) suggested that the Life Orientation teacher allow Grade 8 students to choose a backdrop logo for their Google Classroom page. She set up “a shared document...they could go and vote on each other’s pictures that they had chosen...that meant that each class was individualised by what (they had) chosen.” It is likely that students will take more pride in their work when they feel they have a stake in how it is presented. It could also build a sense of unity amongst the students as they have chosen how to differentiate themselves from the other classes. Further, there is the possibility that young students might have learnt a valuable lesson in putting forward a picture for the logo, arguing its merits and then accepting the result after one has been chosen democratically.

Time constraints

The seventh consideration related to student control is that it should be tempered by time constraints. As ETC4(s) remarks, “At high school you have less (sic) instances of parents doing their...children’s projects...(and) having the iPads...allows the girls to do their work in class.” The ETC must help the teacher to establish a reasonable “time allocation for the work to be done and discussed in class.” This is particularly important for group work, as T4 discussed earlier with her Grade 10 stop motion project, not allowing enough time could be as counter productive as allowing too much time for students to complete their work. It may be that this aspect of a teacher’s planning needs considerable adjustment.

Relieving teachers’ perceived technological burdens

Unusually, ETC2 provided a solution that could benefit her whole staff, particularly if they feel their limited grasp of technology would inhibit the teaching and learning in their classrooms. She signed a contract between her school and an online third-party content developer. T2(s) said this provided staff and students with a “curriculum that the boys can access at home and they can use for revision.” While it could give teachers a sense of security that they and their students had a back-up plan, it is unlikely that an externally developed product would fully meet the requirements an experienced

teacher might have. In this sense it could be compared to having similar benefits and limitations of a textbook. None of the other ETCs followed this route.

Uncommon aspects of the ETC-teacher relationship

Lack of knowledge

There are two uncommon aspects of the ETC-teacher relationship. The first involves a lack of knowledge on the part of the ETC. T4(b) said “I’ve certainly asked...questions where she wasn’t able to directly answer...she said, ‘I’m not too sure about that. I need to do some research and I’ll get back to you.’ Which she always has been able to do.” The point is not that an ETC is expected to know everything, but that he or she should be able to provide a satisfactory answer for the teacher within a reasonable amount of time. It is possible that such openness and vulnerability on the part of the coach might increase the trust between the two.

Acknowledging a mistake

The second involves the ETC acknowledging a mistake. When ETC4 tried to show a specific app to the whole staff, many staff members decided at the outset that it was not appropriate for their subject. T4(o), who had enthusiastically taken to the idea, suggested it might have been a good idea “to maybe show them (what could be done) at the beginning, the example.” ETC4(o) agreed “that was my big mistake. I really should have done it.” T4 thought that giving an example first would help “especially for those departments that...checked out, just said ‘No, I can’t do this. This is too hard. This is irrelevant.’” In light of the earlier discussion under ‘Ed Tech Coach’s Relationships with Teachers: Individual meetings’, the ETC would do well to consider carefully how to approach and engage reluctant teachers as the risk of alienating them could have long term negative consequences and possibly set back the development of teachers’ TK.

At a heads of department meeting, ETC1(s) told teachers “our boys often can’t take a skill they’ve learnt in one subject and put it to another subject.” The next day the students transferred something she had taught them in EMS and applied it to a Geography presentation because “we want to share and we can share and collaborate using Google Slides.” This TK transfer “made a lie of (my statement) completely.” She was delighted to be proved wrong and heartened that the students were multiplying her teaching naturally. In a comparable event, ETC5(s) noticed that some of his young

students had “actually done Keynote as well... (which) wasn’t something I specifically taught, but...I taught PowerPoint so that gave them the idea, maybe then their parents helped.” As ETC5 has spoken elsewhere of parents being amazed by how much more their children could do when compared to their own skills, it may be more likely that the students transferred their knowledge of PowerPoint to Keynote. These examples may be considered as the green shoots of students developing their own technological knowledge. It could also be another hallmark of an ed tech coach’s success.

Younger students’ knowledge

Often younger students surprise the ETC and their teachers. ETC2(s) was astounded that her Grade 4s were able “to create what they did. I think they actually put the Grade 7s to shame.” She put it down to their playing with iPads at home. “They know how to cut and paste, and add effects...so it’s coming through into their school work now.” She found her students were transferring skills they had learnt at home to their schoolwork. It is not too difficult to imagine that they might then teach their school friends what they had learnt. T3(s) noticed the opposite happening: “Younger siblings (come) up with already having the knowledge of how to use iMovie or...GarageBand...because the older siblings...that I have, are exposing their younger siblings and their parents to what they’ve been exposed to in class.” A tentative conclusion could be reached that this indicates that students have taken on part of the ETC role at home and have taught some of what they have learnt about iPads and various apps to their siblings.

Working with reluctant teachers

ETC5(b) gave some insight into how challenging it could be when working with teachers who approach technology differently to himself: “It’s been a learning experience to get teachers to do something that they’re not normally comfortable with.” This particular ETC was the least experienced of the five and was in the initial stages of honing his relationship building skills in a role that was new to him and to the school. There was no precedent or set of procedures for him to follow. It was fortunate that he could meet regularly with four much more experienced ETCs who could support him. He was developing his relationship with the teacher and trying to accommodate the teacher-driven agenda.

On the other hand, in summary, T2(b) expressed his appreciation for the

relationship he had with ETC2: “She has been very, very helpful for me personally as I’ve learnt a lot in terms of how to manoeuvre around the device itself and obviously opening my eyes to new apps...I’m using...quite regularly.” All the teachers expressed similar sentiments towards their coaches. This gives a high level of confidence that others teachers would feel the same. Further it is possible that a teacher with this level of confidence in the ETC’s ability to teach him how to use the iPad and various apps could have a high level of comfort in using and integrating it and so keep technological integration high on his agenda.

Teacher-driven Agendas

School factors impinging on teacher-driven agendas

Device choice and IT support

Although ostensibly all the ETCs and teachers were working with iPads, each school had a different approach to their use and implementation. Each school had one, or in some cases two, PC computer labs. At none of the schools were teachers given iPads but they could purchase Microsoft compatible laptops through a favourable school scheme. Later this was extended to include iPads and eventually Macbooks, although considerable tension had already built up over the issue, setting many teachers against Apple products. The researcher heard many conversations in which teachers claimed that they wanted to use iPads but refused to buy a personal iPad as they felt the school should supply them with one if they were required to teach with it.

Particularly in the high schools, a few parents chose to buy another brand of tablet or bought an older or second-hand iPad that did not have the memory capacity required by the school or that did not have an updated operating system needed to download the few apps that the school specified for each grade. As a result, the two high school coaches, ETC1 and ETC4, taught many apps that were device or platform agnostic as both schools suggested students use iPads, but made allowance for those who chose to use another tablet. ETC2 did some iPad teaching but shortly after this study’s data collection ended, the school choose to move all their Grade 3s to Grade 7s onto Google Chromebooks. ETC3 taught some PC skills to the Grade 3s, and then iPad skills to Grade 4s to Grade 7s. ETC5 taught basic computer skills using PCs for the Grade 0s and Grade 1s, and then some iPad skills to the Grade 2s. In spite of this seemingly chaotic situation, almost all parents chose to supply their children with iPads, while some of the teachers chose to buy their own iPad so that they could teach with

them before the staff scheme came into operation.

Device homogeneity

ETC3 and T3(s) worked in what could be called the ‘iPad school’. Having one device and using the platforms and learning management systems specifically designed for its use, reduced the technical issues teachers and students could face to almost nothing, as all the apps integrated seamlessly with the operating system. This is because once Apple has approved an app, its developers are given the relevant parts of the iOS code to ensure perfect integration. Furthermore: “The platform that we use in Grade 5 is your iTunes U courses...The girls can work off-line which is a HUGE bonus” once they had downloaded the course. This meant, firstly, that the Wi-Fi was never overloaded. As T3(s) commented: “If the device gets lost or stolen, you can STILL view iTunes U using a different device, an iPhone or another iPad or...a MacBook.” Secondly, teaching and learning materials were never lost or unavailable even if the iPad was. Consequently, students “cannot say they don’t have the content material to study for an assessment or test or an exam.” The material was always available and it was up to students to study. This level of student independence is discussed later. Thirdly, she noted: “The communication and the learning and teaching did not stop if a child was absent, was away for some sporting event, or if they were ill or if there were any issues that they were going through.” This device homogeneity, technological simplicity and easy access to work meant that these teachers integrated iPads more completely and more confidently than in any of the other schools. After the initial introduction of iPads in the Grade 5 year, the students learnt to work remarkably quickly with their devices, especially when parents and students followed the guidelines for the digital safety of students and the physical safety of devices. Students needed very little teaching, perhaps one lesson, on how to use the iPad. It was clear that this working environment had the fewest problems when compared to that of the other schools. However, the other ETCs worked in more of a Bring-Your-Own-Device, rather than a homogenous, computing environment and often had to develop compromise solutions.

Compromise solutions

One compromise solution that ETC4 implemented was as a result of T4(b) wanting “to learn how to use...Google Classroom which (she wanted) to access on both (her) iPad and on (her PC) desktop.” She explained, “Most of the technology that I used doesn’t

necessarily have to involve the use of an iPad.” ETC had to find apps which were device or platform agnostic. Some of the teachers in this department could not use their iPads to mark the Movie Maker presentations a few students had tried to submit as they were compatible with an Android operating system. Teachers were restricted to marking them on the student’s device during class time. They could also not be shared with the rest of the class through the Apple TV, so only the teacher and individual student saw them. This would seem to indicate that device homogeneity could lessen technological problems that would otherwise arise. Further, it might reduce the need for compromise solutions and it might also lessen difficulties that could be experienced by members of the school community, especially inexperienced or new-to-the-school teachers.

Working with inexperienced, but motivated, teachers

The ETCs were sensitive to the teacher’s technological comfort levels and to the agenda the teacher had in mind. Nothing in the interviews or observations gave any hint that they imposed their manner of planning, preparation and teaching on the teachers. ETC1(b) helped an experienced but new-to-the-school teacher who was “terrified...about the fact that we were using so much technology. At his previous school he had not been expected to do this and he came into my office and said, ‘Please help me. I need to catch up’” as all he knew of the iPad was how to switch it on: “He had no idea how it could be used.” The ETC started with what T1(b) wanted to achieve: “I would suggest...what content I would want to get across and... (she) would (make) suggestions on what tech might suit that particular content.” In response to this they developed a teaching model in which the ETC1(b) would teach the first lesson for him while he watched. With the second lesson “I’m there with him. Third or fourth class he can actually do it on his own.” After a few months in this high support environment “he’s been able to facilitate (lessons), but now he wants...to have his own device so that he can actually now also learn how to do it.” T1(b) felt he was able achieve his goal of engaging his students through using the tech he felt was “so much more relevant in class cause the kids are way more advanced and now suddenly (I’m) able to close that gap...because my mind was blown as to what the possibilities are, and the potential.” For the duration of the year T1(b) trained with ETC1 and practised in the classroom. He wanted to be completely comfortable with the iPad before he started using it to teach with by himself the following year. He trusted ETC1 as “she (hadn’t) made (him)

feel kind of inferior, or kind of (laughs) like not having the necessary skills, which (he) didn't have but she's been very patient, incredibly patient." Again this seems to be confirmation that it was the quality of their relationship that helped him to slowly change his pedagogy. ETC1(b) continues "Some of my champions...actually don't know how to use (the iPad) but they know what they want the boys to use it for and as long as they get that support for the tech they're quite comfortable." In this respect, T1 is unlike many of his colleagues who had been at the school far longer, as he wanted to learn how to use the iPad as well as teach with it.

T2(s) approached ETC2 with two specific requests. The first was to learn how to use iMovie: "I needed guys to record themselves and do a speech OR a dialogue." He could see three benefits of students recording themselves while speaking in their First Additional Language (FAL): it would help them to see and hear what they said and did at one remove; it would give them an opportunity to improve their speech or dialogue; and to ensure they were fully prepared before the assessment. T2 was different to T1 as he had already used the iPad for emails and other school related administration. His second request was to learn "the easy way of actually asking the boys to submit...so you can mark the...task and...feed that back to the boys." He considered this digital workflow option to be preferable to what he had traditionally done in marking books. An extension of this request was the desire to learn "how to save...the tasks into one platform...so that I can access it from there whenever I needed to have a look at it." He understood the convenience of being able to work outside of lesson and school time. Allied to this is the awareness that if he could access the platform at any time, then so could his students. It appears as though the data is indicating that there is a relationship between pedagogy and learning: as the teacher's pedagogy changes, so does the students' learning.

Working with experienced, motivated teachers

As an experienced iPad user, T3(b) wanted ETC3 to teach her two things: "something new, something creative, innovative that could be related to the curriculum. Didn't want to replace my teaching but to ADD to what I was teaching" as she felt "teaching can become mundane". After learning to use the iPad she commented "it's given me a different way to teach, a different way to extend my girls, to remediate them." Her pedagogy had changed as she no longer felt that she was using "chalk and talk and textbooks" to compete with the technology in front of the girls all the time. She wanted to

“introduce technology and teach them in a way that is conducive to them.” She wanted the technology to work for the students, as her core motivation revolves around teaching being “all about the girls” rather than the technology. Secondly, she was comfortable using the iPad for various subjects and purposes, so wanted “help with...using an app where I could monitor the progress of (any) child.” Using iTunes U as a learning management system (LMS) enabled her to manage the workflow for the whole class and individual students digitally. It would appear to be possible to conclude from her interview that ETC3 and the iPad helped T3 to achieve all these objectives as her pedagogy changed and the way in which her students learnt also changed.

Working the way the teacher intends

The solution must match the need

As will now be discussed, ETCs also need to be open to different ways of working rather than imposing their own preference onto their teachers. Firstly, they might find it counterproductive to push a particular solution that they favour onto all teachers, regardless of the teachers’ needs. ETC4(s) ensured she taught her teachers and students to use the iPad in ways that met their need at a particular time, as the following examples illustrate. She showed teachers in three different departments three different ways for students to use the iPad to film content material. “Grade 11s (filmed) an Afrikaans advert (with) voice overs. Grade 10s (did a meiosis) stop motion project (in Life Science)...The Grade 8s... (recorded) a make-up tutorial... (that) some of them actually used (for Drama).” In each case, although all the activity had film at their heart, the examples can be regarded as confirmation that the ETC ensured that the specific app being used did enable students to deliver the content appropriately. It also allowed students to fulfil different roles, such as directing or video editing or sound editing, as their interest dictated. Having different students learn different roles could enable them to create more complex presentations than if one student did all the work alone. It might be possible to conclude that the teachers and students used different tools for different ends. This could result from the ETC not having a ‘one size fits all’ mentality. This then would seem to reveal the rider to this that the ETC should also be prepared to find appropriate apps for different topics even within one subject.

In this connection, ETC3 found an app for T3(s) about the digestive system that allowed students “to drag and drop the oesophagus...stomach and the small intestine (into place).” Students were also able to see the function of how each organ worked,

leading them to see “the relevance of each part.” They used the app after they had been taught the content. Likewise, ETC4(s) showed Chemistry teachers two different apps. One, PhET Interactive Simulations, dealt with “scientific reactions that you can’t see with the naked eye...so it gives them a...much deeper understanding.” The other, Chemistry, “allows them to mix chemicals together and the advantage there is that the whole thing explodes but it’s not real exploding.” Both of these examples could be construed as evidence for the iPad being used to both consolidate and extended learning, as it gave students a more realistic experience than worksheets, pictures or a textbook would have provided. Moreover it could be regarded as evidence for the teacher’s changed pedagogy also changing the students’ learning.

Occasionally, it could be argued, that exposing teachers to different apps allows them to come to an unexpected realisation. ETC3 got T3(b) and her Grade 5 teachers to complete a project using iBooks and they “realised that we actually found a different platform...other than iTunes U to teach (with) and this excited us...(as it gave) us variety and the...girls wouldn’t get bored.” This comment points to these confident teachers having developed their TK to such an extent that they were able to contemplate using a second platform in their daily teaching, something that was inconceivable a few months previously. It could be interpreted as teachers using the iPad to change their pedagogy with regard to specific lessons or topics and to change the approach of their grade team to planning all lessons in all subjects, in other words, how they operate as a team at a macro level rather than as individual teachers at a micro level.

The teachers must choose how students work

Secondly, they must allow teachers to choose how they want students to work. ETC1(s) explained, “the tasks are online but if a teacher’s getting uncomfortable that too much is online, then we allow (the students) to actually write.” T4(b) decided not to “use the iPad for formal assessments, because the Wi-Fi is not reliable. So it’s fun for quizzes and revision, but often kids fall off the Wi-Fi and then they can’t get back onto the quiz and that causes stress.” Although the Wi-Fi situation has since improved and is stable, at that time she was not willing to risk having students unable to complete an assessment due to something that she could not control and that might impact them unfairly.

The teacher does not have to do this alone as there is merit in an ETC helping a teacher to see a new way of choosing how students work. When ETC4(o) heard of a silly mistake a matriculation student had made in a practical assessment, she suggested

that students “record themselves (doing pracs) so they’ve got a visual record to prepare for the next one.” T4 thought this an excellent idea for her Grade 8s to work in pairs recording the usage of different pieces of apparatus, instead of them making a paper-based collage as they had done previously. They could “use that right through to matric...and (it would get) them to use that terminology as well.” She was so enthused as she could see the benefit of helping students to “get it right because...it’s core knowledge” and started “planning already for next year.” She was excited at changing her pedagogy.

Using iPads does not mean that all work in every subject must be done with them. The teacher’s pedagogical beliefs will dictate how and when technology is used. It is up to the ETC to assist the teacher in matching tasks to appropriate technology rather than being dictatorial about its implementation, without allowing teachers to always fall back on the familiar.

Saving paper and streamlining the teacher’s work

If teachers do not fall back on what is familiar to them, they can make many savings; saving data costs might be one benefit of online learning, saving paper could be another. T2(s) asked his students to “type their creative writing...using Note (sic)... (email) that to me...and I was able to read, and then proofread (their isiZulu articles) before submitting it to the relevant (school magazine) committee.” As it was all done online, none of the work was lost or misplaced and nothing had to be retyped or scanned. Further, the editor would also have been able to submit the articles electronically to the graphic designer, making the whole process much smoother. ETC4(s) presented a solution that mathematics teachers have developed. Although developed initially in another province, the idea allows for students to practice independently and to do better on tests. The “interactive spread sheet...allows you to generate worksheets and (get) answers on the fly. So you can randomly generate ten worksheets on one topic if you’re really inspired to practice.” Furthermore, teachers can inform students “this is how we are going to generate your class test. We will use this spread sheet to do it.” It could be advantageous for students to use this system to understand the format of and to practise answering the style of questions they will meet in any test.

Supporting specialised support teachers

In the same way, ETCs can use iPads to make a real difference in the lives of specialised

support teachers who deal with students with considerable academic barriers or challenges. After the academic support teachers had given these students Khan Academy videos to watch, ETC2(s) divulged, “they were the boys that did best on the test, funnily enough.” It can also speak to the value in using such videos for revision, as teachers do not have to develop all their own materials from scratch. ETC2(s) surmises that as there is “so much available, and so much free stuff out there...why (sic) we invent the wheel?”

Comparisons with other teachers

In an attempt, possibly, to not reinvent the wheel, or perhaps to discover the teaching practices of other teachers, or even just as an interested parent, T2(o) talked to his Grade 3 daughter. She told him “they use Book Creator a lot in Afrikaans. They just go stand with the teacher... (who) looks at all their work and gives them a mark.” Although this teacher gave feedback that was one-on-one, it did not happen as the student was doing the work, nor was the teacher asking students to submit work electronically so that she could mark on her iPad. It might be possible to claim that this practice was little different to the students writing in their books. There is a sense that T2 could have felt he was further along in his iPad journey and used his iPad and time more efficiently.

Copyright and plagiarism concerns

ETCs can be a valuable resource for helping teachers to use their time more efficiently, either by sourcing material they could use or showing them some places where it could be found. This wealth of material could save teachers time and give them access to the good ideas of fellow teachers. ETC2(s) presents it so, “They can browse the many videos... (find) one that appeals to them...edit it...to personalise it...there’s a lot of legal borrowing” which avoids copyright conflicts. T3(s) discloses: “I download the videos beforehand, (ensuring) it’s reviewed thoroughly... (and that) I am allowed to download. Any content that I use, I ensure that it’s something that falls within my ethics and is suitable for the girls.” ETC4(s) is “quite conscious of that...trying to keep all the references for any images I use and making sure that they are ones (that) are publically available.” Not only should ETCs role model this behaviour, they have to be seen to do so and they should explicitly teach staff and students to follow suit. ETC3(s) contends that copyright “cannot be taught in isolation. (Teachers) have to be able to link it back to their experience of using technology. So you always try and get teachers to that behaviour too.” Teachers and students may have a theoretical grasp of copyright and

plagiarism issues, but they might also need practice with concrete examples to apply this to their teaching and learning. She continues, "I've seen my own work being taken and not credited which is most disturbing." In sharp contrast, she explains, "People are happy to share because they know you're going to give them the credit that's due." Thus it might be considered appropriate for ETCs to help teachers update their referencing skills to include different types of resources found on the Internet and to insist that they teach their students follow suit.

Using legal online material could present teachers with an adjunct to their teaching programme, but they should not expect to find a replica of their teaching method, materials or examples. ETC2(s) recounts, "There's lots of teachers who say to students, 'If you're struggling...have a look (at Khan Academy)'...students who have come back and said, 'I watched the video but it's different to what you've covered. Can you explain?'...That's a great opportunity for debate and discussion." T3(s) sees legal online material as "broadening (students') knowledge...it just provides a bit of variety (and)...reinforces what I am teaching." She also uses "Khan Academy either to introduce a topic or to just summarise the topic at the end of a section." This means that if her students are not able to search Khan Academy themselves, they could refer to the videos she would have uploaded to the iTunes U course. ETC4(s) recommended that students do more than simply watch videos. She called attention to another aspect of "Siyavula...or even Khan Academy...where they can go online and get notes and get examples to practice." T4(s) used YouTube videos and other "online sources (as) it's actually rare that I use a DVD or picture or photograph...It's so much easier the other way round." She gives her students links to online material for them to find extra examples or to consolidate concepts taught in class. In this way, it is possible for teachers to help students integrate this material into their understanding. This could help students to gain a broader or deeper grasp of the topic. It may also be the case that teachers find new material with which to improve their teaching.

ETC3(s) mentions the "huge change in our classrooms themselves...when you provide a student with a rubric" as an improvement in teaching. Using a rubric can be considered as a more transparent process as it allows students to check their work against the rubric to see how well they have met the requirements. The iPad allows students to split the screen and "seamlessly jump between the two" with the rubric on one side and the task on the other. If the student also records herself saying the speech,

she can listen “to a recording of herself while looking through the rubric...as opposed to having to go back, read, and tick off, and read, and tick off.” A potential downside to having rubrics available to all, especially parents, is discussed later under “Parents helping with homework and studying”.

Another way in which ETCs could help teachers to meet their agendas is by showing them how one task could meet several different assessment criteria. In the girls’ primary school, first additional language teachers used one task to assess four criteria: spelling, understanding, pronunciation, and graphic layout. Each girl chose ten words from a longer list, sourced their own pictures illustrating each word, and put these paired items into a Book Creator book. Then they recorded their pronunciation of the word, put it in a sentence and saved it with the picture. In ETC3(s)’s words, “They created sort of multi-touch dictionaries...These were shared with other students...so it became authentic learning tool.” It might be possible to conclude that the students’ learning was deepened when they spent more time thinking about the word in this integrated exercise, rather than just learning it as an isolated vocabulary item. Furthermore, it might also be concluded that they learnt from the other students when they saw how their peers had pronounced, illustrated and used in sentences words they had also chosen. The teachers saved time marking one assessment instead of four.

Ed Tech Coach-driven Agendas

The ETC could help teachers save time by having a number of items on their agenda that their experience tells them would help teachers. They could pursue their own agenda and help teachers to use iPads. There are some general considerations that might be helpful for all ETCs to implement. As well as discovering what teachers want to learn, it is probable that every ETC knows some things that would help all teachers, regardless of the subject or grade they teach.

The researcher considers that the non-negotiable heart of the ETCs agenda is to ensure that teachers know how to use the iPad and is aware of its many possibilities. Even if the teacher does not have a need, for example, to use the voice over function to read text aloud personally, it could be helpful for him or her to alert students, particularly those who are reluctant readers or those with a small vocabulary, to this possibility. ETC1(o) pointed out that not only could a Keynote presentation be exported as a PDF, it could also be exported as a PowerPoint presentation, allowing T1 to present in a Microsoft environment as well. She went on: “The apps on the Apples are magnificent. They are

compatible with everything else.” This could be seen as the need for the ETC, at some point, to disclose his or her wider knowledge to the teacher, even if it is not immediately or directly relevant.

Although known for its long battery life, ETC1(o) cautioned T1 that the iPad can slow down if a huge number of apps stay open all day. She also explained how family sharing worked: “You obviously buy... (an) app) for one device... (but)...you can put it onto five devices” even though she knew this had no immediate relevance for him. ETC1 continued: “So because my husband and I are on Family Sharing, I can get his apps and he can get mine.” She further explained the iPad’s “Calendar’s awesome so it links to our school calendar” when he confessed to preferring to use a handwritten diary. It seems as though ETC1 wanted T1 to begin to see the potential of the iPad in a context broader than that of his narrow focus on his teaching.

Furthermore, the data seems to reveal that the ETC should understand in some detail the content that teachers are putting across and how they want the iPad to help them achieve this. To this end, the ETC could suggest and demonstrate appropriate apps for the teacher to use. T2(b) voiced his appreciation for ETC2: “She suggested something very, very nice and very cool for us to use.” A knock-on effect could result as a teacher who is this excited about an app to help teach times tables and bonds in mathematics, could pass that excitement on to his students. This seemed to be the case when he asked his Grade 7 students to create a phone conversation with a service provider. T2(o) reported to ETC2, “They are just running...with it...Some of them are doing some nice and interesting things, calling into a car dealership to complain about something they booked.” This could be a strong indication that his excitement inspired his students to produce work that he, as a well-experienced teacher, found interesting.

Similarly, T4(o) clarified to ETC4 that she wanted to change a task in one section of work. She was “now having to brainstorm and think of something different that they can do, that is not necessarily a big at-home assignment.” She was particularly interested in something that could be done in class that would involve a simple explanation “in terms of a journey.” ETC4(o) requested T4 to show her “one of your (previous) projects because I don’t know the biology.” She then proposed three apps, Minecraft, Puppet Pals and Scratch that could help students to learn about the topic appropriately. This could corroborate the idea that the ETC needs to have a detailed knowledge of the subject content being taught to help suggest apps that the

teacher might find useful.

The role of the ETC might be constrained considerably by the number of iPads available to the teacher. T3(b) discloses that her previous school had “a set of 30 devices...We’d book a time to go into the IT Lab and use iPads. So...the entire school FOUGHT to use that set of iPads.” This is a very different proposition to her current situation where every student in her class owns a personal iPad, the latter enabling the ETC and teacher to integrate iPads more fully across all subjects.

Moreover, T3(b) raises the issues that the ETCs should ask if teachers experience “any glitches with the IT, the infrastructure” and help them to get the appropriate help from the IT department, and in situations where students were not “able to download apps at home” the ETC could set up a system where students “are able to download certain apps at certain times of the day” to overcome this problem. It might also be advisable for the ETC to have a few iPads on hand to lend to students for the school day if theirs has been left at home or if they have not been able to charge it fully before coming to school.

The ETC could also make staff aware of different ways of sharing information. T3(s) detailed three avenues ETC3 had taught her and her students: “The girls (can)...airdrop large content, for example, their iMovies (or)...save it on the shared drive which we all can have access to and there are certain documents (they) can email to me.” The rationale for this could lie in the need for teachers and students to use the most appropriate means of sharing their work, both as individuals and as members of a community, as they could work in different digital formats for different ends.

Providing feedback

The data seems to indicate that the first responsibility of an ETC, after any meeting with a teacher, is to provide feedback. T2(b) explained that “we had a continuous feedback session...She would come in and check...what I (had) done... (collecting) some of the tasks...just to see...what progress (had) made in those lessons.” He explained that ETC2 went further: “She’d given me personal tasks on the side to say, ‘Can you try and put together an iBook and then bring it to me, almost like an assignment of sort...to develop my skills.” It is not a case of meeting once and then abandoning the teacher to continue alone as ongoing contact between ETC and teacher can be seen as vital. ETCs might also consider planning the date, time and subject of their next meeting with the

teacher. ETC3(o) reminded T3 “and then you wanted to talk sometime about apprehension around iPads starting at the beginning of the year?” This important discussion, about when to roll out iPads for the next grade, was too important to be considered at the end of an already lengthy meeting. They decided to “unpack it next week.” Allied to this, the data also seems to indicate that an ETC should be to extend the teacher’s vision of what is possible and the skills required to action this. This is discussed in depth under ‘An Emerging Model of an Ed Tech Coach: Meeting the teacher’s needs’.

Providing backup

Secondly, although an ETC is willing to spend time individually with teachers, there may not always be time to reteach skills and their application on demand. ETC4(s) set up a Google Classroom “for staff development... (with) Help files” so that teachers could refer to it if she was not available when the teacher wanted to meet with her. It is also used to store and share the resources she finds for staff. In effect, this might be characterised as the ETC curating her teaching notes, resource materials and video demonstrations for staff to access as and when necessary. As with the students, the implication could be that teachers choose to read through notes, use resources or watch videos at their convenience. Supporting teachers in this way might have another important function. T2(b) was grateful that ETC2 gave her teachers “a comprehensive list of little things that probably some of us knew and others we did not, how to simply operate...the iPad.” In other words, it could be that this level of backup relieves some of the cognitive load the teachers might have experienced from trying to remember everything the ETC taught them and possibly becoming frustrated in the early days of their iPad usage. Having access to curated material might mean that they could concentrate on delivering their content through the iPad rather than on the mechanics of its use, until their experience and confidence deepened. It might also relieve the ETC of having to repeat instructions.

Providing a learning management system for digital workflow

A third way in which an ETC might pursue their own agenda and use iPads to ease a teacher’s load is through a digital workflow or LMS. When work is given to students digitally, then completed, marked and returned digitally, there can be seven benefits for both teachers and students.

Removal of time and space limitations

ETC1(s) noted that the foremost of the removal of time and space limitations was that

“teaching and learning was not limited by time and place” as students or teachers do not have to be physically together. As an example of teachers, students and parents all benefitting, ETC2(s) recalled parents saying, “We noticed our daughters were less anxious because they were able to keep up with what was going on and didn’t lose out. They just picked up from where they were when they were away.” This data could be cautiously interpreted as the ETC helping the teacher use the LMS to make school work convenient: teachers do not have to help one child catch up work the rest of the class has finished; the student is up to date and less anxious; parents are relieved their child has been has not been disadvantaged. In an analogous manner, this also applies to teachers who have students residing in foreign countries. ETC5(S) taught English online to students in Singapore and Germany and used Skype to video conference them occasionally. Secondly, as ETC2(s) pointed out, “the boys were able to submit as they were going along.” Students do not have to wait for a deadline to hand work in.

Digital marking

The corollary is that an LMS can enable teachers to comment on student work as it is posted. In other words teachers can mark in real time, while the students are working, even if students are working at home, instead of when students have all submitted the work. This allows them to be more effective in correcting students’ misconceptions and efficient in returning work. ETC4(s) explained that students would submit their work “for comment... (so) they could update their work before final submission.” She also saw the value in this “particularly for a subject like LO (life orientation) where they don’t get much lesson time” as having more individual contact with the teacher allowed for more directed and personalised help.

This might seem as though teachers have twice as much marking to do. However, because work is submitted at different times, the teacher does not have to wait until everyone has handed in to begin marking. T3(s) indicated the “turnaround time has now, for me, been cut down by 75%.” It is likely that teachers gain by making as work comes in, while students might gain by having marked work returned to them more quickly. Moreover, it is possible that this could lead to the end product being of a higher standard, which is satisfying to both students and teachers. ETC2(s) described the diligence of some teachers in using an LMS: “Those boys were getting feedback constantly and not just during school time.” Another benefit could be that teachers do not have to carry around piles of books to mark, as the work is submitted electronically to

his or her iPad. ETC1(o) talked to a mathematics teacher who comfortably “sits in bed with her Apple Pen on her big iPad Pro” to do her marking. The iPad and stylus are all she needs.

However, teachers might need to be circumspect about always being available as people might expect to be able to contact them at all times. ETC3(s) remarked, “We’ve had students send in documents at 9.30 at night and later on the Sunday evening as well.” Comments such as these indicate that the ETC and the school would be prudent to help the teachers set parameters for students and their parents around appropriate times and ways of contacting them.

First submission is not final submission

Thirdly, if the system is set up so that the initial submission of work is not the final submission, then students could get feedback, change what they need to and submit a revised final product. ETC5(s) spoke of students who used this feedback loop deliberately to “improve their mark...before the due date is final.” T3(s) found this student habit to be useful as she could give “on-going support and guidance” by sending a quick voice comment, rather than a written or typed one. She continued that this had helped her students to achieve “better results as opposed to...chalk, talk and paperwork and textbooks.” Instant or quick feedback allows for earlier intervention for students needing remediation possibly making it less likely that they would learn the wrong thing. Swift feedback also eliminated boredom as learner paced work meant she could “immediately post new material or new activities” for students needing extension. This suggests that T3 is a highly organised and responsive teacher who could be seen as a fourth level teacher, as discussed later under “An Emerging Model of an Ed Tech Coach: Meeting the teacher’s needs”.

Working to deadlines

Fourthly, the ETC should explain how the date and time stamping of the digital postings’ record is incontrovertible. This could help students to develop responsibility for their work and encourages them to stick to deadlines, as any claims as to if or when work was submitted could be easily checked. When T4(s) gave iPad project work, the students “had specific checkpoints that they had to hand in to me electronically at various times.” As these were Grade 8 students she put in these interim submission dates to teach them to work to deadlines and not leave everything to the last minute. She found

“the girls have been very good at submitting on time or, in fact, submitting and...that’s been much improved over previous methods.” ETC2(s) put it in these terms: “They were constantly aware of what they hadn’t done or had done.” The implications of this are taken up later, under ‘Student learning and deadlines’.

Privacy settings and emotional safety

Fifthly, the ETC should explain the iPad’s privacy settings so that students understand that they see their own work and mark only unless the task is a group one. T3(s) found her “girls became more confident in asking me questions online or through iTunes U.” Those girls who needed clarification and those who needed extension “felt they were in a safe space to ask me...they are at a very impressionable age where they are VERY concerned about how their peers see them.” This could imply that the girls felt emotionally secure enough to ask for clarification, remediation or extension, as they knew their peers would not find out. It could also suggest that is important for the ETC to explain as many settings features as the teacher is able to take on board. While teacher exploration could be valuable, it could delay full use of the LMS unnecessarily. If the teacher is unaware of all features of an app, then an opportunity for student improvement might be missed and they could be disadvantaged.

Comments and marks received privately

Sixthly, marks can be emailed directly to students. Before the high school teachers started their online marking, ETC4(s) showed the teachers how to set up “an Excel rubric... (and) used mail merge to return the marks” to the girls individually. The benefit of this approach might be that all students get their own marks at the same time and are not privy to anyone else’s. This could be seen as a more dignified process and could reduce bullying, as no student is privy to another’s marks and comments, whether through their own deliberate action or accidental exposure.

Ease of use

Seventhly, even if teachers choose not to set up an iTunes U course, the ETC can still help them. As ETC4(s) reveals, “Google Classroom is a very useful tool... (that) allows teachers to watch (videos) on their iPads in their own time...the iPad just simplified the process beautifully.” It is possible to say that high school teachers in particular need technology to be easy to adopt and use, as the pressures on them to get their students to perform well academically are immense, especially for those teaching the Grade 11s

and Grade 12s. If the technology works successfully in one area of their teaching, it might increase the teacher's confidence to use it in other ways.

Providing a range of apps

Counter-intuitively, fourthly, an ETC can follow his or her agenda, through discussing a range of broadly similar apps with a teacher, rather than just one app. When her teachers wanted to flip their classrooms, ETC1(s) presented three apps; Ed Puzzle, Play Posit and TedX. Generally, these would allow teachers to know which students had watched a video at home, when they had started or finished watching it, how many times it had been watched, whether or not they had answered any or all of the questions set on the video and allowed the answers to be marked. The three options let teachers choose the app they felt best suited their needs. The comprehensive metrics could inform their teaching, adding a layer of sophistication to their classroom practice, as they would no longer be dependent on the self-reporting of their students. It could also facilitate the modification of questions as teachers could use the metrics to see sections where students had repeatedly watched the video, possibly indicating their struggle to understand the concept. Naturally, there is no compulsion for a teacher to use only one app to achieve the same end with a different topic or class. As mentioned earlier, the ETC should be able to suggest another app or approach whether for the same topic or a different one.

Providing indirect help

Fifthly, an ETC could use the teacher's agenda indirectly to affect his or her agenda. T3(s) recalls: "We've had girls posting their iMovies onto YouTube where access is given to the rest of the (girls' primary school)." ETC5 had taught T3 how to do iMovies previously and was now extending her capability by showing her how to set up a private YouTube channel so the students could share their work with an invited audience. In a more extended way, ETC1(s) used the English anthology project as a springboard to teach basic word processing skills such as changing fonts, adding footnotes and content pages. The teacher focused on poetic analysis, then on helping students justify their choice of poems in their anthology. Gradually both the ETC and the teacher extended the skills that were taught. The ETC taught the students the technical intricacies of how to blog, while the teacher taught them how to write blog posts. The students had to share their choices with one another and then with the staff through their blog. Once the teacher had moderated all their entries they were shared with the general public. ETC1(s)

remarked “we had boys here fighting about metaphors and similes...at 4 o’clock in the afternoon. So that to me means that learning has occurred.”

In a related manner, ETC3(s) taught basic word processing skills and then ensured that students could also do more advanced things such as inserting GIF (Graphics Interchange Format) images, video clips and hyperlinks into their Book Creator apps books. In exposing teachers to different apps, the ETC might be able to inculcate more than basic word processing skills in the students.

In another variation on this theme, ETC4(s) co-operated with both the ICT and geography teachers. The Grade 8 ICT lesson was used to teach “tools that they needed in another topic. So they took the geography project into account when teaching them the tools in ICT and the mark they got related to both.” This is a good example of rich collaboration between three staff members and the natural integration between two subjects. It is possible to conclude that in the high school and primary school examples, the students did not learn in dry, boring lessons but invigorating classes in which they learnt about the subject and IT skills in authentic settings. Furthermore, the deep level of co-operation between the ETCs and their teachers could be seen as enabling all of them to achieve their respective agendas.

Providing for teacher growth

As the teachers mature their TPK, sixthly, it is likely that the ETC will want teachers, and students by extension, to enlarge their skills base. ETC1(s) relates an extension task that a history teacher gave: “They had to find text, videos, images and then...put together an infographic on the information.” Even if the teacher is not able to personally do the task, the ETC has given the teacher a broader vision of what is possible. Students who can execute such a complex task should have sophisticated skills that will stand them in good stead once they leave school. This could be seen as proof that the ETC has helped both teachers and students to be more flexible in their thinking and in the tasks they undertake.

ETC4(o) encouraged T4 to tweet about her stop motion project: “That’s building up your portfolio effectively.” This could promote the good work done by the teacher in the classroom and also inspire other teachers to try different things. ETC(o) brought up how historians had created excitement about the one hundredth anniversary of “the Russian Revolution on Twitter and that was fun...so every day they literally (tweeted) what happened one hundred years ago.” While she was not suggesting that T4 planned a year’s

worth of tweets, she did give appropriate examples that could be used: “There must be biological milestones...or birthdays of Henrietta Lacks, Jonas Salk. Things tied to your syllabus that you could tweet on the day and that’s relevant to the girls.” With a little planning and T4s admirable organisational skills, these could be set up in advance. It could help students to see the academic relevance of social media.

T3(o) wanted to pass on what she had learnt, “So I think I’ll have a conversation with my colleagues first and then share this exciting new...apps (sic).” This would give them time to discuss how to integrate the Clips app as grade teachers rather than as individual teachers. ETC3(o) again took the growth of T3 further by encouraging her to tweet the Clips “with the hash tag #classroomclips (as) it gets global notice.” ETC3 encouraged T3 to think and work beyond her classroom walls through sharing with a wider community.

Providing immersive experiences

As a seventh consideration, an ETC can introduce something completely outside of teachers’ and students’ general school experience. ETC4(s) exposed life science and natural science teachers and students to Virtual Reality, by demonstrating “a virtual reality tour of dinosaurs and...a whole thing of the different stages of the world with water and plants” to them, respectively. Such immersive technologies could allow for previously unknown insights, as well as the possible development of a sense of wonderment and curiosity, particularly important for students used to the special effects of the film industry. Teachers might be keen to build on this to rekindle students’ interest in their subject.

Providing an antidote to stagnation

In the eighth place, an ETC’s knowledge of individual teachers, could help him or her to intervene in a situation that might arise once a teacher has become reasonably confident with iPad integration. T4(s) confessed: “I find...once I’ve kind of got used to a particular app...that’s it’s quite hard to get out of the mind-set that these are not the only apps. Those are the apps that I’m comfortable using.” She ascribes this to teachers liking “to be in control and we like to know how things work...but it’s also part of the learning curve.” The ETC might need to manage the teacher’s resistance through encouragement to increase their confidence and continued development.

The ninth ETC-driven agenda item, the ETC’s relationship with parents, can be

seen as so important that it should be discussed under its own heading.

Ed Tech Coaches' Relationships with Parents

Security concerns

In the first place, T3(s) highlighted the essential message of the security evening the girls' primary school holds every year with the Grade 5 parents and students at the beginning of the iPad rollout in the second term. "From the time that the security evening starts, the parents are aware the strict measures need to be put in place at home to ensure that the child is not exposing themselves to content that could be potentially dangerous." The school has safeguards in place but determined students could circumvent these. The required partnership between school, parents and students for the latter's safety is stressed. This could be taken as a demonstration of the value the school places on such a partnership and raises the issue of parental responsibility.

Parent responsibilities around digital safety

Secondly, ETC1(s) mentioned, "When I have my parents' seminars...the parents say they want to actually know more about (what) the children are doing." She encourages parents "as part of your homework routine, sit down with your child. Have a look at what they're doing with their iPads...talk about boundaries." She hopes to "strengthen the school-home relationship" so that they "can actually understand what's going on in the classroom a bit more." ETC5(s) has as his number one rule for his young students, "You need to make sure...a parent or an adult is always present." ETC3(s) highlights the need for teachers especially to "guide them in terms of which things you want them to look at, as opposed to just going in a free for all search for information." It is all too easy for students to discover inappropriate and irrelevant material on the Internet. ETC3(s) drew attention to the need for parents to sit with their child to understand the wider context of the work, rather than an isolated, fragmented or cursory glance at what was being done on the iPad. The data highlights that two of the boundaries that the ETC and parents should put in place, especially for junior school and primary school students, are restrictions on their access to the Internet and guidance as to what could be relevant for the task at hand.

Improved digital safety outcomes

Thirdly, there could be improved, positive digital safety outcomes. One outcome might be the improved digital safety of the students as they are likely to be more circumspect in

their online interactions in the face of regular parental interest. Secondly, ETC3(s) states students broach what they have learnt at school about digital safety with their parents. They have contacted her revealing that “‘since you spoke to my daughter about posts on Facebook, she’s now requested I take a certain picture down.’ It’s children being mindful of the world they’re living in.” Through direct teaching in class students might well be more aware of the pluses and perils of online communication and pass this learning on to others. The ETC directly helps students and indirectly helps parents. A third outcome could be increased parental support of and contact with the school. T3(s) explained, “Parents can view the girls’ work through iTunes U. The parents don’t have their own course codes... (but) are able to monitor their (daughter’s) work.”

Parental communication

In the fourth place, giving parents’ course codes would give them all the rights granted to participants that might enable them to be as directly involved as though they were students in the class and so impact the dynamics of the process. This might disrupt the smooth running of the class, so teachers do not give parents course codes. However, when their daughter is working through the course then they are able to see her progress. ETC5(s) notes that the junior school uses an app that specifically allows parents to “log into their child’s profile...and see what’s happening on there...and make certain comments or they can contact the teacher via this platform.” This can be seen as confirmation that it is to everyone’s benefit if communication can be easily instituted and maintained.

ETC5(s) added, “Parents have emailed me and said thank you because...they can see (students) have learnt something in school.” He also received emails from parents saying, “My child has been showing ME how to go to certain...transitions in a slideshow.” Some of these emails commented “on the quality of the presentations that the kids put together.” In other emails parents mentioned, “When they tried to show their kids, ‘No, if you want to do a PowerPoint presentation do it...here’ and then being told by their children, ‘No, mom, you have to go here and do it X, Y and Z.’” Even Grade 2 students can teach and impress older adults. T5(b) divulged that after ETC5 had taught PowerPoint to her Grade 2s, she helped them very slightly as they did most of the multimedia presentation themselves. She recalls, “The parents were amazed at how they could use PowerPoint.” ETC5 highlights students’ technological sophistication

and confidence later when he discusses being in the same position with his ten-year-old son under “Ed tech coaches and teachers learning from their own children”. ETC2(s) mentioned one situation when parental communication increased dramatically. Students were receiving feedback about their submission and “there was one comment there that something hadn’t been done and the deadline was the next day and...then suddenly the parents were sending emails (laughs)...so it did increase the communication between both (sic) teacher, kid and parent.” When parents have proof of learning or lack thereof, this might be corroboration of their increased confidence in teachers specifically and the school generally and might be seen as vital for educational success.

In some instances, it could be appropriate for a teacher to allow someone other than a parent to access a student’s work. ETC4(s) highlighted an unusual situation where the guardianship role in the course was not allocated to a parent, but to a student’s private tutor or assistant, “the specific person who monitors her and goes with her and helps her with her work.” This very high level of academic support, paid for by the parents, is unusual but puts the responsibility onto the shoulders of the person actually helping the student with her homework. The tutor would not have been able to fulfil her role if she did not have access to the student’s work on the iPad. This could be confirmation that when parents or guardians take responsibility for ensuring students do their homework, this responsibility is removed from the teachers’ shoulders.

Parents helping with homework and studying

Parents helping with homework and studying, fifthly, could be promoted by their having all the resources in one place. ETC4(s) found it useful to help her younger daughter plan her studying. She could “go online and say, ‘Show me what’s on your (Google) Classroom’” to see if past papers, memos, and blank copies of the tests had been uploaded so they could work through them and check their answers afterwards.

ETC2(s) added that all the resources for the Science Expo were “put onto iTunes U...videos, examples of other people’s work, iBooks. It was just like a complete tool...even if (the kids) weren’t at school the parents were also able (laughs) to be involved with it.” It is possible to characterise iTunes U as functioning as both a collation of resources and tasks and as a learning management system, with the extra merit for students of being able to work offline once they have downloaded a resource.

This leads to a concern ETC3(s) mentioned which had been expressed by some

parents: when their children use “the iPad, are they working or are they playing?” One solution that might spring to mind would be to encourage parents to be involved in what their children are doing, naturally without doing their homework for them. Nonetheless, ETC3(s) comments that parents trying to do their children’s homework can run into difficulties: “Most of the time (laughs) the parents don’t know how to use the app, so the kid just goes, ‘Just, argh, I’ll do it. You don’t know what’re doing.’” The students’ technological sophistication might serve their and the teacher’s interests better than their parents doing the task would do.

However, having all the resources and tasks in one place, to which parents have unfettered access, might have a potential downside, which the ETC could help teachers to deal with positively. ETC2(s) remarked, “Parents had looked through one of the rubrics and had got in contact with the teacher because they didn’t agree with how...a rubric had been done.” Certainly it could be seen as more appropriate for parents to express their concerns before the task was marked, rather than afterwards. Teachers could feel their authority would be under threat when parents were so involved. However, “nothing was hidden so the conversation was opened and the rubric was changed.” This could be termed as another example of the benefits of open communication between role players.

ETC3(s) warned of a rising trend of parents “having an emotional response to something (and) immediately contacting a teacher.” For this type of decontextualized emotional response, an ETC could be a valuable sounding board for teachers wanting to discuss how to approach such a situation. Furthermore, without going into specifics, ETC3(s) suggested that teachers could use such situations to teach “students their responsibility in the sense of when I write an email (or comment) to my teacher, this is how I’m going to write it...iTunes U is a very open format (and allows teachers) to role model digital citizenship.” This could be seen as representing improved professionalism on the part of the teacher.

ETC4(s) relates how “personal accountability...came up quite a lot in (a) discussion (at) the Parents’ Connect (meeting) on social media.” Almost more than any other, this aspect of digital citizenship is an area of great concern for many parents who might feel powerless in the face of their child’s absorption with, and, in some cases, dependence on, social media. At meetings such as these, many parents might be open to hearing about ways in which teachers deal with the same situations in the classroom.

Teachers do not want to alienate parents, as they are vitally important in a student's education, but teachers and parents acting in concert could bring about powerful, positive change in many areas, especially in the lives of the students.

Modelling ethical behaviour

Sixthly, ETCs can role model ethical behaviour for parents. ETC3(s) "contacted (parents) directly and requested their permission to either place the photograph of their daughter without her name, or her name without the photograph" in material related to her being made a finalist in a competition. "I remember the impact that had on the parents... (who) said how impressed they were that the school had followed procedure...and that it was being role modelled in a good way." In many respects ETCs could be held to a higher standard of behaviour and parents might learn from them how responsible online communication could highlight their child's achievements while also protecting his or her and the family's privacy.

Ed Tech Coaches' Relationships with Students

Teaching with students' work

As well as good relationships with teachers, ETCs could have good relationships with students, who may often be keener than their teachers to become technologically competent. ETC1(s) did not want to bore her students when teaching about hoaxes and viruses. She gave them some content and asked them to do more research then "put together vodcasts... (with) photographs" and voice overs explaining the content because "if you have to explain something you have to understand it." This may provide a potentially irresistible way for students to be deeply engaged with an authentic task if the ETC informs them that the best task will be used as a document for class revision later in the year or for her to teach that section to the following year's students. As mentioned earlier, the data reveals that students like to teach their peers and they give another perspective, possibly different to the teacher's, when they explain content to their fellow students. This is taken up again under 'Students as teachers of technology'.

Learning from students

ETC1(s) has an excellent relationship with her students perhaps because she trusts them to help her with technical issues: "If I need to find something out, I normally go and find a Grade 8 boy, cause they're very quick (laughs) and they're sometime (sic) know how to sort something out better than me." In the face of such humility which student could

resist helping his teacher? In a like vein, ETC4(s) learns from her students. She co-ordinates a group of girls interested in technology called the Web Rangers. They are pulling together their own website to help fellow students with their iPad issues. One girl has been doing a lot of work on the website “and she is teaching me all sorts of things about Google...It has been a good exercise of using technology collaboratively and being taught by the students.” It is possible to declare that both of these ETCs have done more than learn from their students, especially such young ones, as they also reveal their humility and self-confidence. It is a confident ETC who is willing to learn from much younger students. This situation was echoed for ETC4(s) in an interaction between Grade 8 and Grade 12 students when “matrics came in to ask my help for something and my Grade 8 Web Rangers went off and sorted it out for them, and taught them how to do green screen...it was lovely for both of them.” These empowering experiences could enhance students’ confidence in their technological capabilities and set up a virtuous circle of achievement, empowerment and progression.

Similarly, ETC2(s) recounts “one of those Aha! Wow! moments (laughs) that you didn’t think was possible (laughs).” She spent some time creating her own world in the Cospaces app the night before she presented it to her Grade 5 students the next day, with resulted that surprised her. “I think in the first hour of having one Grade 5 class, I learnt more than what I taught them.” When one boy created a tree house she asked, “‘It’s all very cool, but how do you get up there?’ because from what (she’d) understood...you could only look, walk around on ground level.” He suggested, “‘Let’s put a ladder there.’ And I’m like...that’s far too logical.” They found a PNG (Portable Network Graphics) of a ladder, put it in at an angle and “walked up the ladder and into the tree house.” Her openness to the possibility of learning from the student and her willingness to let the student solve the problem, led to deeper learning for both of them. She did not need to take control and possibly get in the way of the student’s self-interest driving his exploration of the app.

Empowering Students

Sometimes helping a student use their self-interest to drive the exploration of an app happens entirely fortuitously. ETC3(s) explains that a young student “was often at school until late...I would let her play on the iPad...She suddenly became this iMovie whizz kid and everybody was looking to have help from her.” This could be perceived as

a sympathetic teacher helping a student rise above her unfortunate circumstances, who then used her self-developed TK to benefit those around her and carved a position of respect and status for herself amongst her peers.

Allowing students to learn by doing

ETC3(s) gives a second example of students learning about technology by using it. Her students read three class novels over the year. She asked them to pick one character “and create a Tellagami animation of (that) character doing a monologue” instead of writing a traditional diary entry to show their understanding. The animation had to look, dress and speak like the character. The others students had to guess which character it was and offer evidence for their choice, especially if they thought the character had been misinterpreted. “There was a lot of fun and debate...and also having to figure out how the app worked.” Having confidence in students’ ability to work things out for themselves could be technologically and emotionally empowering for them.

Using technology to strengthen students’ emotional connections to material

One possible way to strengthen emotional and mental connections to the topic being taught is to use illustrations of situations students of a similar age found themselves in. ETC1(s) asked, “What they wanted their digital footprint to be like.” One of the tasks entailed watching “a video about a young guy who was actually fourteen but online he made himself twenty-five.” This was a precursor to writing up “what they would want to do to keep their digital footprint completely positive.” She concluded that the students responded more positively to this video exemplar than to a lecture.

ETC3(s) revealed another way for an ETC to help students connect with a text on an emotional level. In sketching the background to the novel ‘Buddy’ by Nigel Hinton, she referenced BBC interviews the author had given and showed “some music videos of Buddy Holly music that had been listened to by the character’s father.” This enabled her to “start discussions within that iTunes U course based on how they’re feeling, as opposed to just an isolated ‘Let’s watch the DVD’...or showing them pictures which are just two-dimensional.” In effect she set the scene by giving her students peripheral, but relevant, information which enriched their watching of the movie and reading of the novel. All the students had access to all the material in the course and could refresh their memories whenever they wanted to remember a particular point or song. The point could be made that this preparation gave the students a deeper and

richer understanding of the context of the novel and of different characters' emotional worlds, possibly making it easier for them to make connections with their own lives.

ETCs could help teachers to give students a task with connections to their own lives. ETC1(s) raised the possibility with the history teacher of using podcasts "to discuss how World War II had changed certain parts of life." Some children discovered that their "grandmother had actually been in one of the bombings of London...So it was really worthwhile because it actually made it real for them." Strengthening emotional connections to content material might make it easier for students to learn and remember that material as they may feel more emotionally invested in the material and thus the task.

Student-created resources

When the ETC has helped the teacher to give control of some activities to students, as ETC1(s) notes, students gained by "making their whole content...their own because they had to choose...which information was important." When students do research they need to investigate several presentations of the content. They do not necessarily accept the first source as the only or best one. They might need to rework the material to assess its suitability for answering the task at hand. ETC3(s) put it in these terms: "Maybe this person doesn't know what they're talking about and perhaps I could question it and come up with my own version?" Students might become generally more critical of resources presented to them and so more willing to create their own versions.

Students solving technological problems

Apart from creating resources under a teacher's guidance, sometimes students take on smaller aspects of a teacher's role, such as solving technical problem. ETC3(s) commented that students were "less anxious if they got stuck, now that they have their own iPads. So if they're busy doing something and one way isn't working, they problem solve amongst themselves." Partly, this may be as a result of students using their iPads daily in different lessons and becoming aware of different ways to achieve the same end and partly because they are keen to use them and so they apply their minds to the problem. "They're quick to say, 'Oh, well, I've got an app that can do that. Air Drop it to me. I'll fix it for you and then I'll send it back to you.'" Within any class there are often one or two students who are keener than the others to develop a wide range of IT competencies. They might take on the role of the local expert. It could be a great relief for teachers to be able to call on, or rely on, students in the class to solve problems beyond their own level of

expertise. Further, the other students might hold these technological gurus in high esteem. In this situation, it could be to the teacher's and the students' benefit to have students with diverse capabilities and interests serving each other. Those students who are more technologically confident may want to share their knowledge and help their peers and teachers. The discussion now turns to a fuller exploration of students as teachers.

Students as teachers of content

Technologically and academically confident students, who also want to share their knowledge, could be in a strong position to teach their peers about content in more flexible ways than many teachers. ETC4(s) elucidated this idea in some depth:

"I actually watch how the students do this on their phones and iPads quite a lot. They'll send each other questions and (my older daughter) will Voice Note and answer back, or she'll answer a Snapshot with their bit of code...and say, 'Well, you've left out... (or) you're going to n not n-1.'"

In this way and using a variety of apps, a student could get an immediate answer from a more informed peer. It is likely that the academically strong peer, rather than the teacher, would be able more quickly or flexibly to solve difficulties.

Students as teachers of technology

As introduced earlier under 'Teaching with students' work' an ETC could encourage teachers to extend academically strong students by getting them to make videos to supplement the course material and help weaker classmates. ETC2(s) validated it as empowering students who know "they're creating something that's authentic...they are challenged...and excited...that they're not just doing it for a teacher anymore." This could be encapsulated as students being given authentic tasks not busy work. ETC5(s) refers to junior school students also helping each other informally in class saying, "Please show me quickly...how you do that." As mentioned before, students enjoying helping their classmates and this peer teaching can be very well received and beneficial for all concerned. It certainly lifts the responsibility for dealing with all tech issues from the teacher's shoulders.

It may seldom be the case that teachers are more technologically confident than their students. Students often seem to take ownership of their own technological development and could move at a faster pace than their teachers. ETC2(s) showed one teacher how to run a Kahoot! quiz with her class. "They loved it SO much that it became quite viral within the school. Eventually another teacher said, 'No, I'm tired of

creating Kahoots. You're going to create the Kahoot now for the class.'" The enthusiasm of the students and the reluctance of their teacher could be responsible for enabling the students to learn a new skill.

Sometimes the skill the students have learnt could be considered to have crossed a line. ETC2(s) discovered that "because (the primary school boys) couldn't access what they wanted to at school, they went through VPNs (Virtual Private Networks) to gain all the access." She had to put it in the context of stealing data from the school. She has also had to speak to them "about downloading illegally off the web." In these two aspects they could be seen to far outpace their teachers and it becomes the job of the ETC to explain to the students what they have done wrong and to rein them in.

Another way in which students could cross a line, albeit unwittingly, is if they have not been made aware of the possible dangers of the Internet and the implications of using different apps thoughtlessly. The younger the student, the more guidance they might need in searching for information. It is not at all desirable to have younger students working online without any restrictions. Accordingly, T3(s) listed some of the boundaries that the girls' primary school had put in place. "School emails were not allowed for anything personal...They could not send each other messages during the school day... (or) photos...(or) access any games." This recalls the 'Security concerns' discussions with parents and girls held when the iPad rollout took place. The girls were reminded of these boundaries more than once as the school took its responsibility for the safety of the students seriously.

Students and copyright and plagiarism issues

Students have differing skill levels that sometimes might mean all students need to be taught something more than once. ETC5(s) starts the teaching on plagiarism with the Grade 2s by reminding them, "The words on the Internet (are) somebody else's work...you need to find the information you need and...write it down in your own words." T2(s) considers that the iPad helped his primary school students' "research skills...because they don't just go and copy and paste. They can search appropriately and they can...look for keywords." T3(s) teaches the expected behaviour and models it in her teaching: "We cannot use something without permission, so we do the same for any information, photos or videos." ETC1(s) teaches "a whole skills programme leading up to our One Research Task (ORT) in Grade 12." Amongst other things this covers

foundational research skills such as referencing and plagiarism several times during the five years of high school, beginning with the Grade 8s. These lessons are reinforced during leadership sessions and life orientation lessons. ETC4(s) agreed that while “digital citizenship...was quite explicitly taught in ICT where we spoke about referencing and plagiarism,” it is also taught in other classes. T4(s) considered there to be a “progression (as) the senior girls are very good at (referencing)... (while) the junior girls are getting there.” The importance of this might lie in the skills being embedded in subject tasks rather than being taught in isolation, outside of the context of any specific subject. This could mean that students are ready to apply these skills in their ORT and might be more prepared for tertiary education.

Students and icons

Sometimes only some students need to be taught something, such as those icons now widespread and generally understood universally, as ETC3(s) discovered in an unusual context: “I had some students come and ask me how to put on a DVD player.” When she pointed out some of the universal symbols, such as those for Power and for Play, one student said, “So I don’t actually have to be able to read Japanese or Chinese to use the remote. I can just look for those universal signs.” This points to the ETC needing to have some knowledge of a baseline level of skills that each student has, before moving on to more complex teachings.

Student learning and deadlines

Another aspect of an ETC’s relationship with students is to help them take ownership of their learning and be able to work to deadlines. ETC3(s) referred to the practice of each school of having one of the deputy heads be solely responsible for publishing assessments dates in the termly calendar. This means, “the child can’t fake or remove or delete anything that’s there” and that parents can check on deadlines at any time. ETC2(s) gave “an example of where the boys tried to jimmy the system.” Work was due to be submitted when they told her “all our work is lost” as the documents had contained a virus. When she pressed the history button “we got back all their work and could see how much they hadn’t done.” She continues, “I strongly believe that the iPad makes the kids own their learning more because (sighs) there’s not as many excuses (laughs).” Teachers benefit enormously from having irrefutable evidence of students’ poor work ethic. Concomitantly and unsurprisingly she discloses, “The kids who’ve

always managed to get by NOT doing their work don't like the technology because it now shows up that they've been skipping out on stuff and ducking and diving." It may be possible to suggest that working on the iPad helps students to develop more responsibility for meeting their own deadlines.

T4(s) commented on her department's practice of requiring students to do all their work on their iPads "and it's not an option to do it in written form." The ETC and the teacher could use the digital trail of time and date stamping to help these students manage their workflow, as well as those perfection-driven students who do not want to submit because their work could be bettered. ETC5(s) granted, "It's actually very difficult for kids...to get around not doing work." However, "I'm still teaching them...how to actually type." These junior school students were still able, though, to submit video work, as discussed earlier under "*Students taking responsibility*".

Student presentations

In the past an ETC might only have needed to guide students in bettering their digital presentations. ETC3(s) clearly remembered students trying "every transition... (writing in) yellow on white paper... (and using) blurry (images) that had been stretched out of proportion." However, she contends "now that they inhabit a world that is so rich in media" they are more adept at using effects "to...evoke certain emotions from people." In other words, they understand the relationship between how something is presented and what it is communicating, how presentation can intensify the essence of what they are trying to say. In order to do this, students must "see it in their minds." Using iPads to develop this type of thinking could be instrumental in making students creators of content that is presented in a more sophisticated manner.

Allied to this, ETC3 commented on another benefit of allowing students to learn how to use different forms of video presentation. When students used the Clips app to make short videos "they also start to appreciate that those good one, two minute ads actually take a lot of work." In other words, students might start to deconstruct the video advertisements they see in their minds and use this knowledge to improve their own video presentations.

T3(s) affirmed that presentation quality has improved. "The girls have stretched the band really far and seen, 'Okay, I've done this in this iMovie, what more can I do to...give it that wow effect?'" It becomes the role of the ETC to equip "them with the

tools to be able to make that happen on the screen.” This also points to ETCs helping students to plan their content and its presentation simultaneously rather than sequentially.

T4(s) was disappointed in the quality of some of the presentations her high school girls gave. She debated modelling either what she considered to be a good presentation or what she would like to see, but she did not want her choices to restrict theirs.

Student leadership

An important role for an ETC working with student committees is to help them use the iPad for their administrative tasks. ETC4(s) disclosed that her Technology Committee used “Google Keep so they can go onto the iPad or phone and they can do up the To Do list and share their notes with each other.” Collaboration at this level keeps all members of the group informed about developments and acts as a permanent record of their activities. She continues that her MeLT committee is “looking for videos for an online bullying campaign, which they will pull into their website but they will also distribute through other channels.” She ensured that such important resources are not found in one place only and encouraged students to think where they could situate the information they find so that it is easily accessed by those who need it. She also helped the Peer Mentoring Committee to go “for a (Google) Classroom solution to share past papers, which they are managing themselves.” The value of this lies in the ability of any student to access past papers as a revision tool and the fact that teachers do not have to find old papers when students request one. It is also important to note that the material is made available for students by students. It could be termed as a more indirect way for peer teaching to occur.

Teachers’ Relationships with Students

Teacher mobility

T1(b) approached ETC1 with the desire to learn to use an iPad to “catch up”, as mentioned earlier under “Working with inexperienced, but motivated, teachers.” He described himself as “very old school, very much chalk and talk” as he had “been teaching for what, 20 years and (had) never used tech,” although he had used a whiteboard. He had “never used an iPad” and felt because he was “very lacking in this area and (his) lessons were maybe a little bit... (not) boring, but routine.” His first goal in

“using an iPad, using more tech would...engage the students more.” His second “was really the ability to walk around the class” while teaching as he “wanted to get more kind of amongst them.” With its long battery life and wireless Internet connectivity the iPad does not need to be tied to power or network cables. This means that the teacher is not tethered to the desk either and can move freely around the room holding the iPad.

Classroom management

T2(s) was very aware of the potential danger of using iPads in his language class: “For the little boys that I work with you need to...avoid...distractions...keep them focused on what they need to do.” To this end, students must lock their iPads away when he enters the room to teach, until called to take them out. Ruefully he said, “Boys will always try to find gaps in between to do what they (laughs) want to do...so, I try to be as strict as possible.” He related that “Yesterday they were celebrating. They thought because I (laughs) had a Coca-Cola in the morning, they thought maybe that made an effect on me because I said to them (laughs) ‘Take out your devices for this lesson.’” He notes that the boys delightedly made fun of the connection between the drink and his instruction. They “try as much as possible to come with ideas and creative ways of actually engaging and using their devices,” especially in the third term when they are more independent. A strong case could be made for clear and unambiguous device management by teachers, especially in the early days of iPad usage. It might also accentuate the need for the development of school policy or procedures around this issue.

Student independence

Student independence becomes more important in high school. T4(s) characterised the teacher’s role as a facilitator rather than someone who spoon feeds students:

“It’s more saying to the girls, ‘This is what I expect of you. How you choose to present it is your choice. Choose the appropriate app. You’ve got to submit it on time.’ I think it’s all part of skills that are very important to take them through to independent study at tertiary level.”

High school teachers should be mindful of facilitating thinking and independent work in their students. There is a need to prepare them for their final matriculation examinations and for the rigours of tertiary level study.

Students trusting teachers

An ETC who ensures students use an LMS to its fullest betters their relationship with

teachers. ETC3(s) gave a comprehensive account of this phenomenon. She detailed how students, especially the introverted or less confident ones, communicated more clearly and more freely with their teachers when asking questions online than they would in class. "The questions come through in a far more personal way and so the teacher's responses can come through in a personal way." Their anxiety and vulnerability did not come into play, as they perceived themselves to be in a safe space. ETC5(s) added to the idea of better and more frequent teacher-student communication. "We've had kids on...iTunes U where there's basically a discussion going on in the class...a kid can sit in the corner and...comment on what has been said...even when you submit...you can submit it privately." This form of communication could allow for some reflection time as typing is not as fast as speaking and all students are able to participate, not only the loud, the quick, the confident or the extroverted. It could also allow for students to comment on their own work. ETC5(s) considers "discussion...an incredibly valuable tool for learning, especially PEER discussion." This form of peer teaching will be discussed more fully later under "Students as teachers of content" and "Students as teachers of technology".

Teacher comments

According to ETC2(s), an LMS such as iTunes U, allows teachers to give written, verbal or video commentary. The speed and ease involved in giving verbal or video commentary could allow "the nuances and emotions behind what a teacher's feeling when they are marking" to come through. It is quicker to say, rather than to write, a detailed, specific comment that is less likely to be misinterpreted than a terse 'See me please.' It also prevents the teacher from covering work with a tsunami of red ink that can be so disheartening that students ignore the comments entirely. Furthermore, recorded "verbal feedback gives (students) those cues and then the child can listen to it again (and) reflect on it." This could give "a sense of development because with each new submission... (both student and teacher are) able to see how they've progressed."

Students' use of technology for their own purposes

ETC5(s) encouraged teachers to allow English FAL students to use the iPad "as a dictionary and then also to actually type the work before they write it into their books so they can see whether or not there's...that little red line...(indicating) mistakes." In an unexpected way, this could verify students using digital technology to improve their

handwritten work. They used the newer technology of iPads to circumvent the difficulty experienced with the older technology of pen and paper. He also noted that some teachers allowed students to type up, print out and then paste this work into their notebooks “because some kids’ handwriting is just illegible and you can’t read it...It was, in some ways, an inclusive way of doing things.” This could be an example of iPads providing an equitable solution to students who might have been disadvantaged previously through their illegible handwriting, as well as allowing the quality of their thinking to compete with that of students whose handwriting was easier to read. T3(s) offered a twist to students typing instead of writing: “They find typing out much easier, so they use it for their planning...I’ve also had girls using the app Notes to take down their homework to use it as a digital diary.” These comments could be cited as examples of students using technology for their own ends and in ways that meet the needs of their self-interest.

Developing student presentation skills

An ETC could also help a teacher to increase students’ confidence in expressing their opinion in an exciting and non-threatening way. T3(s) compares her students before and after they used iPads. Those who were “initially hesitant pre-iPad, have now become more vocal. They’re able to talk up...share...interact. They are somewhat almost forced into situations where they have to stand up and do a presentation.” The net result is two-fold: “Every girl is extremely confident to stand up and do a presentation at any given time, whether it is prepared or unprepared” and “my girls are now not afraid to try different things.” It is almost as though by focusing on the iPad and not themselves the students have grown in confidence and experience far beyond what was the case previously and that could have been predicted.

Developing student opinion

ETC3(s) recalled asking students to create “their own video book reviews and they were linked to QR codes and Aurasma triggers which were then placed temporarily on the books.” There was no sense of a review being right or wrong, as it was the student’s opinion. Their interest was piqued in that instead of writing a review, with its potential to be covered in red ink, students were required to make a short video. They could film themselves speaking or they could let an avatar speak for them using apps such as Tellagami or Puppet Pals. Linking the video to QR codes and AR triggers so that

multiple apps were used in concert adds another layer of sophistication to the presentation and none of the steps were beyond the capabilities of primary school girls. These completely individualised products could be as enjoyable for the teacher to mark as they were for the other students to watch, to say nothing of the delight in finding someone who enjoys the same book that you do. Again, this could be considered an affirmation of the teacher helping students to produce assessment work naturally integrated with technology for an authentic audience. The technological skills the students develop are likely to become second nature to them, as these were not taught in isolation for assessment purposes in an IT class.

Authentic tasks

Integrating learning and technology for authentic purposes could attune students' creativity on a scale they may not have explored before. In the latter half of the year, Grade 7 students in the girls' primary school investigated a topic of their choosing and presented their findings in a Visible Learning Project. ETC3(s) gave an account of one environmental awareness project. The student "came up with a song...wrote the lyrics and recorded the music using GarageBand...and created her own music video." On the day when parents and the rest of the school were invited to visit the project displays, they were "listening to an original song while...watching the (original) video for that song." This was far outside the bounds of what the student would have been expected to do for the project. When teachers trust students in this way, it is possible that the students' self-interest could lead to creative exploration and the burgeoning of self-development in ways that advance them and enrich others.

Students learning from experts

As well teachers learning from others, the ETC could help students to learn from experts outside the school. ETC3(s) helped a primary school science teacher set up a Skype session in the library about female anatomy with a young, female, German academic, who spoke good English. In preparation, the students "all had to watch videos and read the online content first, before asking...the (teacher moderated) questions they wanted to ask." Although the teacher facilitated the session, the girls asked their questions of the researcher directly, with the whole class able to see and hear her responses as the interview was projected onto a large screen in the library. They were able to ask her for clarification on points they had not understood. The interview went slightly over time as the students and teacher used each question as a springboard to

another. While not involved, the researcher was able to observe the interview and witnessed what seemed to be a very powerful learning experience for the students.

There is also the possibility that students learn from others in the sense of learning about one subject from the teacher of another subject. ETC3(s) framed it as, “You’re blurring those lines between the different subjects...I’m not learning in boxes cause I don’t live in boxes. I live in a blended environment.” It is unlikely that specialist teachers would start teaching another subject, but students might begin to appreciate the interconnectedness of knowledge in spite of the essentially arbitrary nature of subject divisions. In other words, the effects of silo teaching and learning might be lessened.

Students as teachers of content

T4(o) was concerned to teach students good digital skills when their content presentations were to be shared: “They have to give this presentation a title...it’s in the rubric.” ETC4(o) was pleased with this because “you reinforce good digital skills.” This highlighted that subject teachers could reinforce what the IT teacher had taught previously, so students heard the same message from different teachers.

T2(s) tells of boys correcting each other in class: “We’re looking at the subtitles where there’s either a spelling error or language structure that was used incorrectly...and then they’ll make a comment...‘You’re supposed to actually have used that word this way.’” When students pick up on and correct their peers’ work, they could be considered to have mastered the content and are taking on part of the teacher’s role. T4(s) told her high school students, if “somebody gets stuck (with content)...‘You have to ask somebody else first, to see if they can explain the answer to you, before you come and ask me.’” Furthermore, she added that her students often share their good presentations as “girls who are not that organised like to see other girls’ notes (or) assignments to help them prepare for exams.” Students may find it easier to ask another pupil for help rather than the teacher.

As raised under “Teaching with students’ work” the ETC could help teachers to get student buy-in from the start, through students creating learning material for the class and by managing opportunities for in depth peer teaching. In some cases it could be appropriate to use two apps to achieve this. ETC3(s) showed a technologically resistant teacher how to use the Decide Now! and Book Creator apps. Crucially, at the beginning, the teacher labelled a Decide Now! spinning wheel with the different rock types on her iPad and asked each group to spin it to be randomly allocated one of the

rock types. The teacher asked her students to create rap songs about the different types of rocks. "It really turned a very boring subject into one of the most exciting...Before she had no buy-in... Suddenly they...were filming themselves, changing the lyrics to songs to fit in with...the rock choice they got." All the videos about one rock type were put into one Book Creator book. "Everybody got all the completed books (as) their material for that section." The students had become creators as well as consumers of digital material. T3(s) observed, "The girls were responsible for their own learning." Similarly, when T3(s) and her colleagues gave the girls an "opportunity to use Book Creator...for doing heritage trails... (and) the smelting process...the teacher did not have to present all the content." ETC3(s) asserted that the students exhibited "a higher level of thinking and engagement because of the creative process of creating the work." T3(s) considers it as being a "much more effective way of getting the learners to remember content." The students might be learning as they do the research and present in these authentic situations. Moreover, she assessed the value of iPads to lie in the way "it has created a LOT of independence" as students "now realise that they are responsible for how they study, when they study and if they want to study and things are always...(on iTunes U) so that they can always revisit lessons." As co-creators of material, it appears that students teach themselves as much as they teach their peers.

As students become more technologically astute, their natural curiosity could lead to peer teaching outside of formal classroom lessons. ETC3(s) recounted how the primary school girls learnt to make goo. "One (girl)...learnt...watching a YouTube video and... (friends) learnt how to make it from her, but... (others) who were not her friends (said) 'I want to see how to make it.' And they were all trying different recipes." Students were willing to share "content or ideas with each other." In so doing they learnt from each other. Students could also teach their peers about technology. She continued "IT skills that are taught in isolation" have no value, as she contended that those skills need to be applied to authentic tasks. For these students, they took the IT skills developed in their academic lives and integrated into their TK and then applied them to their personal lives. This spontaneous teaching and learning could be considered as a form of personal development.

Students as teachers of technology

Personal development and authentic tasks could be considered to build on each other.

An ETC might encourage teachers to extend academically strong students by getting them to make videos to supplement the course material and help weaker classmates. ETC2(s) validated this as empowering students who know “they’re creating something that’s authentic...They are challenged...and excited...that they’re not just doing it for a teacher anymore.” As noted at least twice previously, this seems to occur when students have been given authentic tasks rather than busy work. ETC5(s) referred to junior school students also helping each other informally in class, “Please show me quickly...how you do that.” Again, as mentioned earlier, students seem to enjoy helping their classmates and this peer teaching can be very well received and beneficial for all concerned. It certainly could lift the responsibility for dealing with all technical and technological issues from the teacher’s shoulders.

The researcher was unsurprised that there was no instance in the data of teachers being more technologically confident than their students. The earlier examples, given in “Students as teachers of technology” those of students developing their own Kahoot! quizzes and figuring out how to set up a VPN, could testify to their interest and capability in contrast to that of the teachers.

T2(s) recounted peer teaching of technology in class, as happened when two students used technology in an unexpected way. The boys had been unable to finish recording their dialogue. He gave them a solution: “Go home. You and your mate can get together.” When they returned the next day, they had come up with a novel solution, as they were unable to meet the previous evening. Each boy recorded his part of the dialogue separately. In class they “put together their recording on one (iPad)” then connected it to the Apple TV, and played their dialogue for the class, which solved their limited time problem. T2(s) confessed: “I’ve never asked them to do the flip switch dialogue, but they thought of something like that and they applied it, so to me it’s them trying, and being creative and using the device to the best of their abilities.” This could be seen as proof of students using technology to solve an authentic problem in an original and clever way.

T2(s) also noted that the boys often asked for permission to re-record videos they made. They were “looking for quieter venues around the school.” They were not satisfied with their early attempt and wanted an opportunity to better it, as they wanted to be prouder of their final product. He lets the boys use their iPads “to edit...rerecord and rewrite our dialogues.” He saw value in allowing students opportunities to improve their

work and deepen their learning. He said the boys also taught themselves how to do voice-overs and subtitles when developing dialogues with cartoon character apps: “Obviously, I (sighs) haven’t even instructed them to do that...but they came up with that themselves.” Yet again the students solved their problems without direct teacher instruction. This could speak both to the intuitive design of the iPad and to the willingness of students to try even if they risk failure.

There is a pertinent aside to this discussion of students as teachers of technology. After the data had been collected and analysed, ETC3 was asked to speak about social media and online safety at a nearby school that also catered for students from Grade R to Grade 12. She was delighted to find that a fellow panellist was a former Grade 6 English pupil talking on the same topic from a matriculant pupil’s perspective. Although they had been out of touch for six years they recognised each other and the pupil told ETC3 that she had come to be highly regarded by her peers when she joined this high school as a Grade 8 pupil. In other words, she had consolidated and built on the teaching she had received from ETC3 in primary school and was confidently presenting her opinions and experiences to an adult panel of teachers who themselves had strong backgrounds in implementing and using technology. For ETC3 it was an affirming, although unexpected, recognition of how she had integrated iPads in her classroom years before. Again it could be considered as a hallmark of her success, which idea is discussed later in the Conclusion.

Ed Tech Coaches and Teachers Learning from Others

Ed tech coaches learning from teachers

Two ETCs spoke about learning about iPads with their teachers when they were first introduced to them. Much more so than the other vastly more experienced ETCs, ETC5(b) learnt a lot from his teacher: “informally...we’ve had a couple of discussions that we...sit and talk about something new that we’ve found or something that I’ve seen or something that she’s looked at.” In this respect he learnt in much the same way as ETC3(b) did in the early years of her relationship with T3: “I was just interested to see how she’d used (an app) and if she’d done anything new with it or discovered anything that I hadn’t tried. So, we were learning from each other.”

ETC4(s) revealed, “I’m taught things by teachers when they are trying things out.” For example, “I hadn’t known that you could do an assignment to multiple

classes until I was sitting (with) the Afrikaans department and they also taught me stuff on Kahoot...so you're always learning." The Afrikaans teachers had learnt co-operatively from each other and passed this onto ETC4. Referring to the Grade 5 teachers implementing iTunes U, T3(o) put it succinctly: "I think it's a symbiotic relationship. We all helped each other." It could also be a powerful experience for teachers who are not afraid to experiment, to teach the ETC the finer details of using an app. It could also instantiate how self-interest can motivate deeper learning as the teachers use the app in their teaching, unlike the ETC who used it for demonstration purposes only.

Teachers learning from students

As well as learning from their ETC, teachers could also learn from their students. T2(s) remembered: "The guys have shown me some nice things." He took what they had taught him and made it part of his "actual responsibilities, to go learn how they did that, so I can be able to assess and give them feedback." T2(o) also directly "asked them to (T2 plays a recording of boys speaking in Zulu)...just as an afterthought, just so I could see what could be done." He was willing to explore and let his students guide him. In these instances, the teacher could be described as having learnt from his students and they helped him to change his pedagogy.

T3(s) argued for a slightly different approach, that it is important for teachers "to actually show (students) that we are receptive to what they want to teach us and we're not afraid and we're actually quite proud of them for taking that bold step." As an adult she considered that the students learn more quickly than she does. They also see "how they can use it in different ways and how they can extend themselves." More than quietly listening to what her students show her, she is "quite happy for the girls to come to (her) and say, 'Ah, do you know you can do so and so in Explain Everything?' I learn from them and they learn from me." This level of respect could both empower students and increase the learning available to all members of the class. T4(s) divulges, "If I get stuck...very quickly the girls will tell me, 'Oh, you do this' and it's very quickly rectified." T5(s) tells how a Grade 2 boy taught her about an iPad function she was completely unaware of:

"A child in my class, his hand was broken, taught me how to disable AutoCorrect on the iPad. It's something I just didn't think of and he just showed me like, 'This is what you do.' And I was like, 'Thank you very much.' (Laughs)"

She laughed because the boy was about to write his spelling test and AutoCorrect would have changed all his incorrectly typed words to the correct spelling. It could be said that his honesty compelled him not to cheat and his helpfulness taught his teacher something in a very polite way.

Ed tech coaches and teachers learning from their own children

ETCs and teachers also learn from their own children. ETC5(s) declared, “My son is actually sometimes the best teacher for me because he is 10 years old...We think that...we’ve been using these things for so long, so you think you can’t teach me anything, but...they sit and fiddle.” When he tries to tell his son, “This is the one way to do it” his son has often shown him more than one way to achieve the same end that he had not considered. This seems to point to the benefits of curiosity, experimentation and being willing to fail.

A very similar scenario played out for T4(s) who acknowledged that when she gets stuck, her 16-year-old son became her first port of call: “He LOVES to show me how to do things...He says, “Oh, that’s interesting, but did you KNOW that you can also do that, or have (your students) tried this?’ And I’ve learnt quite a few things from him.” In turn she could share what she has learnt from him with her students.

Personal Professional Development

Although all the ETCs have many years of experience, they are largely responsible for their own professional development, as the following comments reveal.

Learning from peers outside of school

ETC1(o) mentioned “I’m on Twitter and I follow Twitter and that’s how I do my own self-development.” The ETCs also learnt from their colleagues and peers in other schools through workshops and social media as suggested in the data. They attend and sometimes present at workshops held at other schools. Most of the ed tech coaches, especially those that are Apple Distinguished Educators (ADEs), make a point of attending the yearly, two-day iPad Summit. They are accompanied by up to five teachers from each school, both those who are new to using iPads and those who are more experienced iPad users. The worldwide ADE community is particularly active in sharing best practice and ideas from amongst their members, regionally and globally. This is done through yearly events such as the ADE Worldwide Institute, the ADE Academy and also through Google Apps for Education (GAPE) Summits. They also

communicate through hosting or participating in Twitter chats and weekly webinars.

Learning from peers at school

The ETCs also learn from each other. They meet bi-weekly with the Rector and the IT manager in an in-house professional learning network to share best practice, discuss common challenges and hear invited speakers. This is especially important as each school is a complete entity on its own and follows its own technological pathway. Also, the varying, sometimes conflicting, needs of the individual schools make synergy difficult. At the core of the ETC's job is the need to work within the expectations of his or her school, so synergy between schools is a desired but not demanded goal.

Learning alone

In some instances, ETCs taught themselves how to use the less well-known features of the iPad and how to use it in the classroom. In many personal communications, ETC3 spoke of reading or writing online about her teaching experience at home at night. She actively sought to increase her knowledge through reading and then writing about her thinking in her eponymous blog in order to clarify it. It was only because we had worked together in the same office for five years that I found out about her continual drive to learn more. I did not have the same access to the private learning of the other ed tech coaches. Eighteen months ago, when the girls' high school ed tech coach also came to work in the library office, she spent most of her time with the teachers in their offices or classrooms. This meant that there was not the same time for discussion around her personal professional development. I spent no time at all with the other three coaches outside of the interviews and observations. I did not use this knowledge of one coach's private learning to frame an interview question and so missed an opportunity to find out about it. The others did not mention it to me in the interviews when I asked if there was anything else they wished to say and I did not think to ask them about it. As the last question in a nearly hour-long interview, it may have been that they had been so focused on their relationship with the teachers and students that the issue of their personal professional development did not merit more attention. The coaches might have taken it for granted that they had had to find their own ways to learn and assumed that I would know that. This can be seen as an area of weakness in the data gathering. As one of the identified negative effects of the researcher being the sole collector and analyst of the data, it might call into question one part of the dependability of the qualitative analysis.

However, for the other ed tech coaches, ETC4(b) typically used her meeting time to “think about an idea” with her teacher, and to be able to “try it as well, to actually go into the application. Or, if I’ve gone and researched something to...show it to the team.” When ETC4(b) suggested that T4 require her students to make a stop motion video to show the process of Mitosis, neither had made one before. Accordingly, ETC4(b) did a thorough job in preparing herself, her teachers and the students for the task:

“I...did a project, showed her how to do it...came into the class to show (the students)...and put together a Help File on (Google) Classroom for everyone, so the other departments could get ideas from it, as well as giving her stuff that she could share on her Classroom for her pupils.”

Learning with your teacher in an iterative process

ETC5 was in a slightly different situation, as he was both the IT teacher and the ETC, and he worked with teachers of very young children. However, he used the same technique as the other ETCs, when meeting with his teacher. ETC5(b) formulated it as an iterative process “in which...we’d have a discussion about how we could change or implement or even just incorporate.” He continued, saying “it’s a constant discussion on how and what we can do...we go and revisit and see what works, what didn’t work...and revise...and change what we can or what we need to.” He was used to being flexible in his approach to helping his teacher. He also was comfortable in learning from his teacher. This was confirmed by T5(b) who revealed her technological strength in her relationship with ETC5: “I’m quite good on the iPad...We’re always bouncing ideas off each other.” If she found something “of interest that (she) thought (they) could use in the grade” she would discuss its possible integration with him in their impromptu meetings. T5(b) had had “a personal iPad for years” before she got another one through the school and started teaching with it.

Summary

This study undertook background and specific question interviews with the five ed tech coaches and five teachers at one school, as well as observations of one coaching session between four of the pairs. The transcripts within each group were analysed individually and comparatively. The findings and the discussion of the same were written up together. The discussion reveals that a successful ed tech coach should focus on ten major areas as summarised in Table 6 below.

Table 6: Summary of an ed tech coach's focus areas

CATEGORY	SUB-CATEGORY
Teacher-driven Scheduling	The teacher's needs and timetable ETC availability Approaching teachers
Relationships with Teachers	Feedback from teachers Individual meetings Relationships based on trust Working at the teacher's pace Giving some control to students • Students taking responsibility • Students teaching students • Student creativity • Student metacognition • Students doing more than expected • Student buy-in • Time constraints Relieving teacher's perceived technological burdens Uncommon aspects of the ETC-teacher relationship • Lack of knowledge • Acknowledging a mistake Younger students' knowledge Working with reluctant teachers
Teacher-driven Agendas	School factors impinging on teacher-driven agendas • Device choice and IT support • Device homogeneity • Compromise solutions Working with inexperienced, but motivated, teachers Working with experienced, motivated teachers Working the way the teacher wants to • The solution must match the need • The teachers must choose how students work • Saving paper and streamlining the teacher's work • Supporting specialised support teachers • Comparisons with other teachers • Copyright and plagiarism concerns
ETC-driven Agendas	Providing feedback Providing backup Providing a learning management system for digital workflow • Removal of time and space limitations • Digital marking • First submission is not final submission • Working to deadlines • Privacy settings and emotional safety • Comments and marks received individually • Ease of use Providing a range of apps Providing indirect help Providing for teacher growth Providing immersive experiences Providing an antidote to stagnation
Relationships with Parents	Security concerns Parental responsibilities around digital safety

	Improved digital safety outcomes Parental communication Parents helping with homework and studying Modelling ethical behaviour
Relationships with Students	Teaching with students' work Learning from students
Empowering Students	Allowing students to learn by doing Using technology to strengthen students' emotional connections to material Student-created resources Students solving technological problems Students as teachers of content Students as teachers of technology Students and copyright and plagiarism issues Students and icons Student learning and deadlines Student presentations Students leadership
Teachers' Relationships with Students	Teacher mobility Student independence Students trusting teachers Teacher comments Students' use of technology for their own purposes Developing student presentation skills Developing student opinion Authentic tasks Students learning from experts Students as teachers of content Students as teachers of technology
ETCs and Teachers Learning from Others	Ed tech coaches learning from teachers Teachers learning from students Ed tech coaches and teachers learning from their own children
Personal Professional Development	Learning from peers outside of school Learning from peers at school Learning alone Learning with your teacher in an iterative process

The table above summarises the findings and discussion of the role of an ed tech coach as gathered from the data. These nine focus areas form the basis of an emerging model of an ed tech coach. This model presents the one underlying principle that all ed tech coaches adhered to, that of changing the teacher's pedagogy. Five other principles flow out of this basic principle: Meeting the teacher's needs; Knowledge of applications; Collegiality; Modelling desired behaviour and Meeting the students' needs.

CHAPTER 6: AN EMERGING MODEL OF AN EDUCATIONAL TECHNOLOGY COACH

The previous chapter both presented and discussed the data findings. Now the ten focus areas coalesce into six principles that underpin an emerging model of an ed tech coach. The first and most important one underlies all the others; it is for the ETC to find out how the teacher wants the iPad or app to change his or her pedagogy for the better. The other five emanate from this: meeting the teacher's needs; knowledge of applications; collegiality; modelling desired behaviour and meeting the students' needs.

The ETC needs to balance teachers' needs with the school's approach to education. ETC1(o) spelt out their school's approach as being a "traditional one. We've got a balanced approach. So if they've got their tablet open with that (document), I would suggest in their...summary book where they study, they start making notes." This statement recalls her earlier one, under "The teachers must choose how students work" about teachers allowing students to write in their books if they felt too much was being done online. This school wants a both-and rather than an either-or approach to traditional and new technologies being used.

In a highly pressurised environment where academic achievement is a major driver of the school ethos, some teachers, especially those teaching Grade 11s and Grade 12s, were prepared only to learn how to teach with the iPad. This involved an initially high support environment until the teacher was comfortable using the iPad without the ETC being present. However, some of the teachers felt able to also learn how to use the iPad for other purposes. ETCs need to be sensitive to the motivation of both types of teachers, as well as being able to meet the needs of the novice and the experienced teacher.

In meeting the needs of the teachers, where possible, ETC3 preferred to help the most resistant teacher first. She knew the positive impact that being successful in this instance would have on the rest of the staff, as it could create a more positive climate in which pedagogical change could happen and it could stop the negative influence that a fearful or resistant teacher could have on the other staff members. In a similar way, it could also be of benefit to teachers if they were helped with a section they did not enjoy teaching or which they knew the students found challenging. If using an iPad helped them to teach difficult or challenging work better, then they might be more receptive to

changing their pedagogy in other ways as well. ETC1(o) summed this up when she told T1, I “find ways to make technology make your life easier, not to make your life more difficult.”

Changing Teachers’ Pedagogy

The underlying principle of an ETC’s success is to find out how the teacher wants the iPad or app to change his or her pedagogy for the better. For example, ETC1(s) recommended to one teacher that students be given “a video with the questions and they can re-view it and they can repeatedly (sic) watch it, so that they can actually get better.” However, the girls’ high school’s mathematics department wanted the students to be given multiple opportunities to answer questions and learn from their responses: “if they get it right there’s feedback to tell them why...if it’s wrong there’s feedback to a site or to a Google Doc...to show them where they’ve gone wrong, and they can continually do it.” In this scenario, getting students to repeatedly watch a video would not have helped them as they need to actively problem solve to engage with the content rather than more passively watch a video explaining what they should do.

The ETC needs to know what the teacher wants to achieve and why in order to meet his or her needs. There are four ways in which an ETC can change a teacher’s pedagogy. They do not necessarily follow on one from the other as it depends on the relationship the ETC has with the teacher as to which approach will be most effective. In the first place, the ETC needs to help teachers to begin to think about doing a familiar section in an unfamiliar way. Secondly, the ETC can help the teacher to slowly change his or her pedagogical practice. Radically changing pedagogy, thirdly, can be successful if certain preconditions are met. Lastly, co-operatively changing pedagogy works when teachers in the same grade or department work together to intentionally change their practice.

In the opening pages of this thesis, an idea about an apprenticeship was mooted. This detailed discussion on changing teachers’ pedagogy sketches out some ways in which the ETC can help teachers to serve such an apprenticeship.

Reimagining changing pedagogy

An ETC can help teachers to reimagine a familiar task. Instead of talking about our voting system and getting students to complete worksheets, ETC2(s) helped a Grade 6 teacher to integrate iPads to achieve the same ends. “They had to create a film to persuade others to join their campaign” after they had created posters and met with

journalists to video interview them. “So the kids that preferred video could choose that. It wasn’t expected. The people that wanted to write the campaign...had that opportunity...It just allowed all children to have their voice.” It could be argued that students were given a richer, more authentic task than the previous one when they heard only what the teacher said as they were able to interact with professionals outside of the school. Moreover, it could be said that the task also gave each student an opportunity to express their thinking in a powerful way as the task gave each of them a voice and a choice, deepening their mental commitment to and emotional involvement with the task. Giving each student a voice and a choice can help technologically resistant teachers to positively change levels of student engagement with a dry topic they do not particularly enjoy teaching. Slowly and carefully ETC3(s) went through the steps for labelling the game show type spinning wheel in the Decide Now! app and through the steps for creating an iTunes U course, with the Grade 5 teacher responsible for doing the geography prep on different types of rocks. By using these two apps, the ETC helped the teacher to get student buy-in from the start and get students to create learning material for the class. Crucially, at the beginning, the teacher labelled a new spinning wheel with the different rock types on her iPad and asked each group to spin it to be randomly allocated one of the rock types. “They spun and they got the rock and there was no argument about who got which rock and why.” The teacher asked her students to create songs about the different types of rocks. “It really turned a very boring subject into one of the most exciting...Before she had no buy-in....Suddenly they...were filming themselves, changing the lyrics to songs to fit in with...the rock choice they got.” All the videos about one rock type were put into one Book Creator book. “Everybody got all the completed books (as) their material for that section.” The students had become active creators instead of being only passive consumers of digital material. The teacher had used one app to build into the second one to maintain class harmony and to get the students to focus on the task at hand, rather than on any perceived unfairness on the part of the teacher in allocating a rock type to a group. It is possible to see ETC3(s) as the catalyst to change, successfully, the pedagogy of a technologically resistant teacher in spite of her reluctance and aversion to doing so.

Slowly changing pedagogy

Although not appointed as an ETC, T5(b) also helped reluctant and averse teachers to change their pedagogy, as she was the Grade 2 IT champion. She was aware that “some

teachers are not comfortable with technology and to overwhelm them with apps...it's like they shut down." Her solution was to expose teachers to "two or three that are simple and easy for them to use, and then next term we add in another two. By the time the year has ended they're quite capable with six." Shortly after our second interview she left class teaching to become an ETC for the Grade R students. Her level of experience rivalled that of ETC5 and their comfortable relationship led to mutual co-operation. Although her students did not often use the bank of iPads available to them, she did find ways to use them. Firstly, she used the wheel-spinning decision-making app *Decide Now!* on her iPad to ensure all her students were satisfied with decisions as to who should run errands or light the candles in Chapel. She would always ask, "Is the wheel going to decide or should I decide?" When they choose the wheel, she would remind them, "Once the wheel has spoken you can't argue." They never did, as there is no favouritism in randomness. Secondly, on a slightly more elevated level, she would let students play with the *Get Out* app. The goal is to get the red block out in as few moves as possible. T5(b) found it particularly good as "it starts off easy and they're like 'Yes, I can do this.' Then it becomes so difficult that it challenges them." She was concerned to give her students early success to build their confidence through this problem-solving app. Thirdly, if she was teaching number sense to one group on the carpet, she would find "an appropriate app or game for the children to play that's maths related" as an extension activity that dovetailed with what she was teaching. Fourthly, she enlisted her intern's help to integrate iPads into a lesson when she had to attend a workshop on critical thinking. They took a book out of the library, came up with questions based on the story and put these into a *Kahoot!* quiz. On the day of the workshop, the intern read the story; the students completed the quiz on the iPads and then did an art activity based on the story. She emphasised that "it's...those kinds of things (that) show that actually we just need to do little things but we can integrate effectively." She had peace of mind that her students were fully engaged while she was out of the classroom and her intern improved her TK and TPK through developing the quiz, as well as benefitting from learning a simple way to integrate technology with young students. Fifthly, she carefully structured the tasks she gave them as their reading and writing skills were still developing. For their heritage theme, the students first said a speech on their cultural heritage. Then they found pictures or took photos with the iPad of "the things that they had in class that they had brought for their speeches." Next, they

wrote a story on paper, in pairs. T5(s) was careful to remind them that they “need to be able to read what (they) wrote” before getting them to practise in class. Finally the text and picture or photos were put into Book Creator on the iPads. These were shared by passing the iPads around as they were not the students’ personal devices and they did not have access to a shared drive, as do the older students. Compilations of projects using Book Creator or Toontastic by other students would also be available to them in this way. T4 would be characterised as a fourth level teacher because of her technological expertise and confidence. This idea of describing teachers according to different levels is discussed more fully later under the heading “An Emerging Model of an Ed Tech Coach: Meetings the Teacher’s Needs”. All these examples could be deemed to represent the teacher modelling the behaviour she would encourage those reluctant and averse teachers to emulate. This could be a most persuasive way to let them see that small pedagogical changes could have big effects.

Radically changing pedagogy

In complete contrast, an ETC is also a catalyst for technologically confident teachers who want to radically change their pedagogy. In one bold move, fully supported by the ETC, the boys’ high school drama teacher “decided to put her whole term’s work, which was film study, onto our Google Classroom.” ETC1(s) showed her the specifics of setting Google Classroom up and helped her develop group and individual tasks for the boys. Each group member chose a role, such as director or editor, and explained to the others what their role entailed. The goal was to reshoot two scenes from a movie they liked, but with no budget. It was based on the concept of “sweded movies” from the film “Be Kind, Rewind.” The complementary work that the ETC and the teacher did in changing lecture-style teaching into rich, authentic tasks led to “a lot of fun and (the boys) learnt about movie making.” This was possibly because the teacher had a clear agenda for tasks that matched well with the iMovie capabilities of the iPad and because she worked confidently with these and she allowed herself to be guided by the ETC. The students could also have been considered to have gained a wider understanding of the roles needed for their group work to be successful. It is possible they also matured their technological competencies through co-operating with each other.

Co-operatively changing pedagogy

In a similar vein, an ETC can also be a catalyst for less technologically confident teachers who already work co-operatively within one department and want to change

their pedagogy. The girls' high school's Afrikaans department had put their film study onto Google Classroom when they decided to do the same for their poetry section. They loaded a presentation and questions on each poem onto Google Classroom. ETC4(s) articulated their innovation, "They put in audios of that poem as well...so the children can hear the cadence, the voice." For First Additional Language learners this could offer an extraordinarily substantial recapitulation of teaching previously limited to a lesson heard once only in the classroom. Learners might be able to hear more than once the teacher's pronunciation, intonation, cadence and rhythm in reading aloud work being studied, while the text is in front of them, whenever they choose. This could be a compelling rationalisation to give students more time to hear the language, particularly if the only exposure to that language happens at school.

ETC3(s) helped a primary school deputy head and mathematics teacher to develop an iTunes U course for "the more challenged (students) with startling results. She chose a section that was particularly difficult. This group of students excelled. They did it in half the time and the results were phenomenal." The effect on the students and teacher was unequivocal, "The kids came back and said, 'Wow, the fact that I could go back and watch that video again, or I could read that material again, I understand it now.' So she doesn't teach it any other way now." This is a dramatic instance of a teacher changing her pedagogy leading to increased understanding on the students' part. A cautionary note must be added that not all cases of iPad integration might have such immediate benefits or pronounced improvements for students.

ETC4(s) helped a high school science teacher to make videos to introduce some new sections of work. The teacher "committed to the class they'd never be more than 10 minutes" which made it an attractive option for the students. They responded very well to watching these short videos at home "at their own pace and their own time" and then discussing and answering questions on them in class with the teacher and the other students. There were also worksheets that could only be completed if students had watched the video and "a lot of quizzes for them to do self-practice." The teacher did not "think it would be good for everything, but that's the point, you want to be able to mix and match." This ETC advocates limits to the flipped classroom approach, as it could happen that if it was used all the time students would soon become less engaged and more disinterested. Certainly the iPad need not only be used to watch videos.

ETC4(s) worked with the English teachers to create "self-marking forms...to

practice English grammar.” This could be represented as these high school teachers not having abrogated their roles but as having given their students an option to receive repeated teaching on the topic. Further, this might be another example of the teachers having changed their pedagogy in a way that improved how their students learnt. This could be a tentative indication of the value in giving students access to resources they can read or watch repeatedly at their convenience and according to their level of need. In other words, it is possible to envisage the students as not being limited to hearing information once only when the teacher presents it in the classroom during one lesson. It could be said that it now becomes the students’ choice and responsibility to access resources as often as they need to, in order to understand, learn or revise. ETC3(s) summarises as follows: “iTunes U is meeting kids where they are and giving them what they need, when they need it, where they need it” especially as the resource is downloaded once and then students have access to it offline, saving on data costs.

The underlying principle of the ETC discovering what the teacher wants to achieve and why has five minor principles that flow from it. These are: Meeting the Teacher’s Needs; Knowledge of Applications; Collegiality; Modelling Desired Behaviour and Meeting the Students’ Needs.

Meeting the Teacher’s Needs

At the heart of every successful ed tech coach / teacher relationship is a deep level of respect and trust. A striking aspect of all the interactions between the ETCs and the teachers was the ETCs’ use of language that facilitated respect and built trust. This is best shown in the interaction between ETC2(o) and T2, where she starts with what she has observed: “I know your boys have used Book Creator.” She praises him for giving control to his primary school students: “(It) was awesome that you just let them do whatever.” Using inclusive language, she gently suggests extending his pedagogy: “But what I was thinking is that we use Book Creator more creatively in the classroom.” She checks her understanding that what he can do with the app is accurate: “How much do you know about Book Creator?” She reaffirms that what he had done was good: “I mean Book Creator is nice for the kids to create content.” She suggests using the app in a way that does more than change what his students do, it changes what he does: “But it’s also nice as a platform for where you structure a lesson.” Finally, she pitches her idea in an open-ended way: “You send them a book and then they complete the book each on their own or in a group or something.” At no point has told him what to do or

suggested that his integration of the app previously had been inadequate. She used tentative words such as “I was thinking” and inclusive words such as “we.” Her tone was friendly and helpful, never intimidating or challenging, as they sat next to each other on the couch.

Allied to the ETCs’ use of language to build a relationship founded on respect and trust is patience. A patient ETC gains the teacher’s trust and helps him or her to move at a pace they are comfortable with to meet their teaching agendas. In practice, this means meeting as regularly as the teacher deems necessary. An ETC who forces the pace risks losing the teacher’s respect and trust and perhaps their co-operation as well, with resistance turning to recalcitrance. There may be an inverse correlation between the teacher’s level of confidence and competence and the length of time an ETC spends with a teacher; the less experienced the teacher the more time the ETC needs to spend coaching, the more experienced the teacher the less time the ETC needs to spend coaching. The relationship between ETC3 and T3 had been built up over eight years. This solid platform enabled them to move at the fastest pace and cover the most ground in all the observations of the ETCs and teachers. The differing pace of learning exhibited by the teachers in this study meant they ranged along a continuum of iPad competence that could be considered to have four levels.

First level teachers

First level teachers had never used an iPad and had no idea of its possibilities. T1(0) was frank about his inexperience: “I think, for me, cause I know nothing, is (sic) a matter of just playing around with it.” ETC1(o) agreed: “It’s intuitive. Once I’ve taught you the basics, this was an overview...you mustn’t be scared of it.” Earlier she had been at pains to encourage him to “never be afraid of touching... (as) with any technology we can fix it.” She wanted to calm his fears of not remembering everything she had shown him and she did not want his progress to be hampered by a fear of deleting or irrevocably altering material. To allay their teachers’ fears, both ETC1 and ETC2 gave a document to their teachers with basic information on it as to how to use the iPad. T1 took additional handwritten notes that he made throughout the meeting. ETC1 was supportive of this practice, as she knew he was comfortable with this way of learning. Her focus was on how he learnt rather than on how she thought he should learn.

T1(o) asked ETC1 to define different acronyms, “What’s the difference between a PDF and a JPEG?” She gave a wider explanation that also included PNGs and

examples of each. ETCs need to give some form of backup for first level teachers especially. ETC1(o) reassured T1 that “whenever there’s a setting, I’ve got a whole document for you as well.” This could be a hard copy, printed information sheet or an online document in a staff development folder in whichever LMS the school uses. This is primarily to reduce the teachers’ cognitive load from limiting their exploring apps and experimenting with them in the classroom. She reassured T1 that she would send him “a summary of everything (she’d) talked about...and when you get your iPad then we’ll sit.” She did not expect him to remember everything he had been told or shown in an hour-long meeting. Although she had explained clearly and slowly, the sheer volume of information he was exposed to and the pedagogical changes he was beginning to realise he could make, were almost overwhelming for him, keen though he was.

As well as explaining how an app works and what it could be used for, the ETC also needs to explain how it integrates with other apps. In discussing how to edit and share images, ETC1(o) told T1 “Now this is where the beauty of...iPads come in. It will look at whatever app you have loaded on your device and it will tell you where you can actually send this to.” Automatically, a list of options is presented to the user to open another app as a vehicle for sharing the image. It is a simple solution that can be used easily and confidently by even a first time user.

Second level teachers

Second level teachers had used an iPad for basic school communication purposes such as email, but not for teaching purposes. T2(s) for example, as a FAL teacher, wanted his students to work on their iPads, but would use his PC to display the language “structures...tasks...explanations...on the screen in class. So I wouldn’t use a device for that.” Then he would ask the boys to create on their iPads what he had asked them to on the screen. The difference between second and third level teachers hinges on the time they had had to use the iPad as a personal device before they integrated it into their teaching.

Third level teachers

Third level teachers had used a personal iPad for some years. T4(b) felt “fairly confident using it, in the sense I was able to use most of the apps that I’d downloaded.” She could access her school email, look at Pinterest, use the Virgin gym app and read novels on her iPad. T4 was a good photographer who knew she did not have to bring her

camera to school as she took “lots of photos...in the classroom...I’ve always got my iPad...to record the expressions on the girls’ faces, to see them getting fully involved.” The convenience and ubiquity of the iPad in her classroom was less intrusive than her camera. This allowed her to take photographs that could “potentially be used for the school magazine.” T4 was not dependent on being taught by ETC4 alone as she drew information from the iPad Education Summit she had attended and from her two sons, students at the boys’ high school, who both used iPads at school: “If I’ve ever got stuck I could actually ask them for help.” Furthermore, if she saw apps her sons had downloaded for school that she could use appropriately she would integrate them into her teaching.

Fourth level teachers

Fourth level teachers had used a personal iPad extensively for a number of years, in their personal and professional lives. As T3(b) put it: “I was very familiar on how to use the different apps” such as Mail, Keynote, iMovie, iTunes U, Edmodo, Nearpod and Google Classroom. Even at this level, this experienced teacher was interested to learn more when ETC3(o) introduced Apple Classroom, saying “you’re going to like this. This is what I felt was a step up from your iTunes U...this is your digital classroom...the management tool.” ETC3 set up a classroom for T3 work in as a student to demonstrate its features, so T3 could practise as a student with ETC3 as the teacher beside her. After a couple of minutes of instruction T3(o) asked, “When will you decide on whether our girls can actually use this?” ETC3(o) replied, “You can start it tomorrow” to which T3(o) delightedly responded “Oh, can I? Oh, wow.” In those few minutes T3 had picked up how to use the app and how to implement it in her classroom. This speaks to both her willingness to improve and to the long history they have together. In other words, a fourth level teacher seems to learn quickly and comprehensively because of her previous knowledge and experience.

Furthermore, fourth level teachers are able to see the integration possibilities in new apps. By way of introduction to the Clips app, ETC4(o) put her teacher’s mind at rest and concisely defined it: “It’s a very easy app. On devices it allows you to create a movie with annotation, voice over, music.” This brevity gave the teacher confidence that the app was something she would be able to understand and implement easily. “When ETC3 introduced Clips to me, I immediately realised I could integrate it in

various subjects; history, geography, English.” She was particularly interested in using it to teach the physical structure of South Africa, as she knew “from previous experiences the girls really (battled).” She knew it would be closer to “real life experiences, something that chalk and talk would not help. Worksheets would not help.” She wanted to incorporate the new technology to change her pedagogy to help her students with difficult sections that they struggled to comprehend, by giving them exposure to more realistic representations of “the plateau, the Highveld.”

What was notable in ETC3(o)’s demonstration of the Clips app, was her way of working with T3 as she demonstrated: “I’m going to open (my app) and you work on yours.” The simultaneous demonstration and practise allowed things to progress very quickly. It was not a case of the ETC telling the teacher what to do and then expecting her to practise on her own later. It also meant that any misunderstanding was resolved as it arose.

It was also very apparent from ETC3’s question “You know what this would be nice for as well?” that she had a good understanding of the work T3 did as she then gave several examples showing how T3 could use the app the next day in her classroom. ETC3(o) continued, “I want to show you some of the...Clips that (ADEs have) uploaded in the community so you can see.” These further examples were of how teachers around the world had already begun to use it. After watching a couple of these very short videos, T3(o) reciprocated “I’ve got all these lesson plans in my head already. (Laughs) History tomorrow.” T3 did not have to ponder how to integrate the technology, the possibilities were readily apparent to her, even for the next day’s teaching, as her extensive iPad experience enabled her to adapt her pedagogy at short notice.

Correlations between teacher levels and the DISA matrix

Although the previously mentioned DISA matrix (Table 2 repeated below) clearly sets out the relationships between instruction, or the lack thereof, by the ed tech coach and the implementation of apps by teachers, it does not give any direct correlation between the four levels teachers seem to progress through and the development of their TPK. The analysis and discussion reveals it is most likely that first level teachers are very dependent on the ed tech coach, as in their Dependent Learning they are told which apps to download and how to implement them. Influenced Learning could be seen as correlating with second level teachers who are reasonably sure of what they are doing and are able to implement apps they have been told could be useful and are somewhat

able to extend themselves. Serendipitous Learning might occur when teachers find a new functionality they have not been shown within an app, such as GarageBand, to share with the coach; they are most likely to be characterised as third level teachers. Autonomous Learning might happen when teachers find, download and implement apps without any help from the coach; these fourth level teachers work as confidently and competently as the coach, even if they might not have the coach's level of experience. As with the difference between the second and third level teachers, the difference between the need for direct coach instruction and no direct coach instruction lies with the teacher's level of confidence and competence. As with the SAMR model, this is not a predictable or inevitable learning pathway but is one that seems to have been demonstrated in this study as the way in which TPK is developed in teachers by ed tech coaches.

Table 2 (repeat): The DISA matrix showing relationships between instruction and apps

THE DISA MATRIX SHOWING THE RELATIONSHIPS BETWEEN INSTRUCTION AND APPS	BUILT-IN APPS	PURCHASED APPS
DIRECT ED TECH COACH INSTRUCTION	1. Dependent Learning: The coach gives direct instruction to the teacher about the built-in apps and their affordances for teaching.	2. Influenced Learning: The coach gives direct instruction to the teacher about the affordances of purchased apps that the teacher will need to buy and download.
NO DIRECT ED TECH COACH INSTRUCTION	3. Serendipitous Learning: The teacher happens to discover an affordance of a built-in app that he or she has not been directly instructed in and applies it in his or her teaching.	4. Autonomous Learning: The teacher purchases and downloads apps and applies their affordances in her teaching with no direct instruction by the Ed. Tech coach.

Knowledge of Applications

Knowledge of evergreen, multifunctional or creative apps

Although none of the ETCs are expected to know everything about every application, they are expected to assess each one's suitability and how their teachers could apply it. ETC1(o) explained to T1, "When we first got iPads we went app mad" but as the technology developed "and using it in the classroom changed, we realised that there might be five what we call evergreen apps that we use." Undoubtedly, Explain Everything and Book Creator would be two of the five, as they are multifunctional and creative apps that can be used in any subject area with students of any age.

Evergreen apps are multifunctional or creative apps rather than content specific

apps. As mentioned under “Meeting the teacher’s needs” ETC2(o) extended T2’s use of Book Creator to change his pedagogy through restructuring his lessons. She put forward the idea of T2 adding “images of clothing that they’ve got to add the Zulu word to.” T2 would format of the book with headings, images and instructions. The latter could be written or recorded in Zulu or both. T2(o) had tried to use the voice over function. He had “typed in a simple Zulu conversation and then the pronunciation from the lady, it was just...” Words failed him as he tried to describe how inadequately the app rendered words in a language for which the developers had not added first added the phonology. He could sort out this problem by recording his speech and adding it to the page as a sound file. Furthermore, it would be more helpful for the students to hear their teacher’s pronunciation, intonation, cadence and rhythm.

The boys would then label images to increase their vocabulary and write sentences to strengthen their knowledge of grammatical structures. In effect, as ETC2(o) noted, “They can have an editable copy” of the book. The boys could work individually or in groups. When their book was complete they would save it and share it with T2 for him to mark it. This example shows only one of the many ways in which the multifunctional Book Creator app could be used by the teachers and students.

Used in this way, Book Creator stands in stark contrast to a content-specific app such as Spellboard. This vocabulary development app has a number of innovative and fun features that help students to practise their spelling but that is all that teachers and students can do with it. Multifunctional apps allow teachers and students to collaborate and they can be used for a myriad of purposes. They are not limited to being used for a single purpose or content area.

As discussed above, under “*Fourth level teachers*” ETC3 and T3 found different ways for students to take control of their learning using the multifunctional app Clips. ETC3(o) put forward the idea of a student taking a photo of a mathematics problem to then use Clips to “talk their way through solving it, and then share it with you.” She summarised the discussion, “The kids create the content. You just evaluate it.”

Additionally, as advocated under “Changing teachers’ pedagogy: Reimagining changing pedagogy” ETC3(o) proposed letting students combine two apps. They could use Clips to make short videos on how to use PE (physical education) equipment and link each of these to a QR code stuck onto the specific piece of equipment.

Trialling and testing apps

A teacher soon realises the need to organise his or her downloaded apps. While ETC1(o) disclosed, “All the apps I have (are) put into folders so that I...can organise it. I have four hundred apps, which is too much.” The point for her is not so much to alert T1 to the need to organise apps, but that ETCs need to trial and test apps before demonstrating them to teachers and students.

Deciding on student purchases

ETC1(o) continued, “So now the boys have a whole list of apps.” Students, and their parents, need to receive a list of apps to download before the year, or, less desirably, the term begins. In discussing suitable apps for a new project, ETC4(o) raised the issue of students’ purchasing a particular one: “We might have to say you’d have to buy.” To which T4(o) responded, “No, and then I wouldn’t want to suggest something like that.” Neither considered that the app was so vital that the project could not be done without it. Both would rather use extant apps to achieve the same, or a very similar, outcome as they considered the teacher’s pedagogy of more importance than the technology.

ETC1(o) cautioned, “A lot of the new apps aren’t being updated for the latest operating system and so...they’re going to fall away.” She put this down to the developers not continually developing the app as they were not making enough money from it. Furthermore, developers often release a free version of an app, while it’s more powerful and productive aspects are subject to in-app purchasing. This brings to the fore the need for ETCs to thoroughly assess an app and explain how it can be used before a teacher, or the students, download it.

Teaching about the iPad and an app

In the first meeting with T1, ETC1(o) had to do two things at the same time; explain how to use an iPad and how to use the app. This can be quite challenging. She chose to demonstrate an app, Popplet that would meet the expressed requirements of the teacher. He confirmed, “Sorry, a Popple is basically a little mind map, is it?” He was able to link what he was seeing on his screen with something he wrote on the blackboard or whiteboard regularly to organise information. She started by letting him change some of the settings in the app, such as the text and background colours. She then compared Popplet to a specific type of graphic organiser: “When a mind map is like a spider diagram.” This enabled the teacher to link what was familiar in his pedagogy to what was being shown as new. After more practice and explanation, she made the point “so

this is like a way of making your thinking visible or to plan it.” In explaining the function of the app, she also gave some ideas for its implementation in a specific topic he wanted to teach. Knowing he wanted to use the iPad to teach and walk around the classroom, she linked what he had asked for with what she had demonstrated:

“So, it’s making you more mobile. It’s making you more efficient. And then linking to Apple TV, you can walk around the class. So you’re not stuck in front... So you would be able to do this real (sic) time...Instead of having to prepare it before hand, because I think that sometimes that’s how we do all our explanations. Instead of...being erased off your board, or having the boys take a photograph of it, you can export it to a PDF and you can actually share it with them onto Google Classroom and they’ll be able then to get all your notes on it.”

In other words, work done in the moment could be saved and sent to the boys. This could be done afresh with each class so the students can see the development of the teacher’s thinking and have a copy of it afterwards. Finally, she noted that he could get the boys to duplicate his actions on their iPads and walk around to check what they were doing, allowing him to “actually give that one-on-one attention.” No time would be lost walking back to the front to resume teaching the whole class as he could teach them from wherever he was in the classroom. ETC1(o) had explained very clearly to T1 the advantage for him in using the app. This was exactly what he had asked ETC1 to show him and how he hoped to use the iPad.

ETC1(o) turned to discuss another app: “The Notes app on a (sic) iPad is fantastic. It’s a very simple little app. You can add folders. You can draw. We’re actually getting the boys to take their notes in it, because it gets backed up to iCloud.” This alleviates anxiety around losing work as all material in iCloud can be accessed from any iOS device, as mentioned previously under “Teacher-driven Agendas”. Not only did she want him to see the advantages of using a particular app for himself, she was also concerned with getting him to understand how the students would benefit from using it as well. When ETCs explain all the features of an app, giving teachers opportunities to practice using it, teachers understand the benefits and implications and are more likely to integrate the app into their teaching. This is especially important with foundational apps such as iTunes U and Apple Classroom that together drive the workflow in the classroom and allow for the management of all the iPads in a class.

Collegiality

As mentioned under “Personal Professional Development” the five ETCs generally develop themselves through sharing with other people.

Sharing with other ed tech coaches

The five ETCs have a calendarised, monthly, in-house meeting with the rector and IT manager. These meetings are critical as they have three functions: to give input into the role that ed tech coaches play within the school, to give official support to them in the face of challenges to this integration and to share their best practices. Even if there is only one ed tech coach at a school it is important that he or she meet with the IT support person and/or teacher and the principal, as the former will resolve technical issues and the latter will take the lead on educational issues, but all three staff members need to interact regularly.

If an ed tech coach works in isolation in a school it is likely that he or she will be overwhelmed trying to resolve every teacher and every student’s technical issues. Such issues should be resolved by IT support personnel, or at the least by the IT teacher. If this is not the case then the ed tech coach will attend to technical issues at the expense of having time to help teachers integrate iPads into their teaching. It is too much for one staff member to play all three roles of ed tech coach, IT teacher and IT support, as the ed tech coach role will often be compromised or neglected in favour of the latter. There should be clear job descriptions and boundaries for each role and these should be shared with the whole school community.

Sharing with teachers within and between departments

As far as they are able, ETCs should be expected to share their knowledge not only with individual teachers, but also within and between departments in their school. Within a department it is likely that this will happen naturally as teachers would probably share with their colleagues something that has worked effectively for them without being prompted to do so. While it might save time for a coach to work with a department as a whole, there is still a need for him or her to work with individual teachers within that department. It might be more appropriate for the coach to share one feature of the iPad or one app with one teacher who is responsible for one specific section of work before sharing it with the whole department. Communal or blanket instruction can be counter-productive. Sometimes teachers share with colleagues in other departments, either because they teach two subjects or because they are friends with someone in another department. To ensure that this type of sharing is not left to chance, the ed tech coach

should teach the same affordances or apps to other departments if it is appropriate to do so, or get the teachers to share their knowledge in a whole staff workshop setting.

Sharing with colleagues and teachers outside of school

This is particularly pertinent for those schools that have only one ed tech coach. The benefits of belonging to a professional learning network should enable them to discuss new trends, to share best practices and to problem-solve common challenges. Without input from others the ed tech coach risks professional stagnation and their content knowledge quickly becoming irrelevant. In a field that updates itself continually ed tech coaches should keep abreast of international trends.

Modelling Desired Behaviour

ETCs should ensure that they model behaviour that is in line with the vision of the school. Good ETCs also model the behaviour they want the teachers to model to the students. ETC1(s) put it this way: “I go straight to the Internet for anything that I need and I use Flipboard to curate. I always reference the sources.” When they give teachers different apps to choose from when setting up a task, they encourage the teachers to do the same for the students. When they say to a teacher, “I don’t know. I’ll get back to you.” it should make it easier for the teacher to say the same to the students or to ask for their help.

Meeting the Students’ Needs

Sometimes students approach the ed tech coach directly. Although not mentioned in the interviews or observations, the researcher often witnessed students (and teachers) approaching ETC3 and ETC4, in the library office, for help with a particular technological problem. This could range from connecting a new device to the network, to needing help in using an app or one of its functions, or even to ask for suggestions about other apps or ways of meeting a particular task’s requirements. If either coach were out of the office, then the other one would offer help. This was a unique benefit for the girls’ schools as both ETCs worked in the same venue and their different timetables and responsibilities often meant that one of them was available to help students or staff with their problems and queries.

Conclusion

The wellspring of the success an ed tech coach is to apply the underlying principle of enabling the teacher to use the iPad or app to develop their TPCK and change their pedagogy in the manner relevant to them. All other behaviours flow from this as

Table 7 shows.

Table 7: Principles underlying an emerging model of an ed tech coach

Principles	Behaviours
Changing pedagogy	Discovering how the teacher wants the iPad or app to change his or her pedagogy for the better • Reimagining changing pedagogy • Slowly changing pedagogy • Radically changing pedagogy • Co-operatively changing pedagogy
Meeting the teacher's needs	Working with teachers at any of the four levels of competence
Knowledge of applications	• Knowledge of evergreen, multifunctional or creative apps • Trialling and testing apps • Deciding on student purchases • Teaching about the iPad and an app
Collegiality	Sharing with other ed tech coaches Sharing with teachers within and between departments Sharing with colleagues and teachers outside of school
Modelling desired behaviour	To teachers and students
Meeting the students' needs	• Re-teaching app functionality • Suggesting other apps or ways of meeting task requirements

The previous chapter, Chapter 5: Portrait of an Educational Technology Coach combined the ten major data findings with a discussion of each of them. This chapter, Chapter 6: An Emerging Model of an Educational Technology Coach, presented six principles drawn out of the groundwork laid out in the previous one, and discussed them in some detail. The last chapter, Chapter 7: Conclusion, discusses the role of grounded theory in this study. Next, it highlights one concern in the analysis of eLearning. Then the six principles in the emerging model of an ed tech coach are marshalled into three hallmarks of an ed tech coach's success, namely vision, escalation and critical mass. Two possible areas for future research are briefly mentioned.

CHAPTER 7: CONCLUSION

This thesis began with a conceptual framework chapter that argued that the iPad's technological capabilities create technological affordances that led to the development of new pedagogical affordances, with the relationships between these outlined. The implications of these relationships were considered: polysynchronous teaching and learning; digitised, enhanced learning compared to digital, transformed learning; student ownership of learning with teachers as facilitators; students as teachers of content and technology; and teachers' triple agendas of content elaboration, academic argument and digital citizenship.

The second, literature review, chapter explored affordance theory in general, with consideration of both the TPCK and SAMR models. This was followed by a scrutiny of the positive and negative affordances of iPad by teachers and students. The Dependent, Influenced, Serendipitous and Autonomous (DISA) matrix looked at the relationships between direct or no direct ed tech coach instruction and built-in or purchased apps. The work of ed tech coaches was briefly related to Kolb's experiential learning theory.

The third or methodological chapter provided some insight into qualitative research with the high points of grounded theory brought into sharper focus. It provided greater depth on the research strategy, purpose and design of the multi-case study, as well as information on the pertinent schools and participants. Detail on the research phases, the audio recording, data collection and transcription of the interviews and observations was laid out.

Examples of how elements of the TPCK and SAMR models were instantiated in the data provided the bulk of chapter four. The contention was made that when ed tech coaches use the SAMR model to build teachers' PK or TK through their CK this strengthens their TPCK and has other benefits for teachers and students as they both work in different ways. A mobile device on which they can work online or offline enables them to learn with ubiquity, flexibility and sophistication. Teachers can offer extension and remediation, while students can work with greater confidence, independence and control over both the process and product of their work.

Chapter five combined the description and analysis of the data in a portrait of an

educational technology coach. Ten major findings emerged:

1. Teacher-driven Scheduling
2. Ed Tech Coaches' Relationships with Teachers
3. Teacher-driven Agendas
4. Ed Tech Coach-driven Agendas
5. Ed Tech Coaches' Relationships with Parents
6. Ed Tech Coaches' Relationships with Students
7. Empowering Students
8. Teachers Relationships with Students
9. Ed Tech Coaches and Teachers Learning from Others
10. Personal Professional Development

Each finding was discussed in depth with supporting examples from the data.

The sixth chapter developed the ten major findings into an emerging model of an educational technology coach, with six principles. The most important principle was framed as Changing the Teacher's Pedagogy through the ed tech coach finding out how the teacher wants the iPad or app to change his or her pedagogy for the better. This was followed by five resultant principles: Meeting the Teacher's Needs; Knowledge of Applications; Collegiality; Modelling Desired Behaviour and Meeting the Students' Needs.

This seventh and last chapter, the conclusion, concisely touches on the role of grounded theory in this research and briefly considers a concern in eLearning analysis. Major tables are repeated as a summarising device. Finally, the conclusion is reached that vision, escalation and critical mass are the three hallmarks of the success of an ed tech coach.

The role of grounded theory in this study

Grounded theory proved to be a most useful theoretical methodology. Its twofold purpose was, firstly, to yield a system of meaning that was richly described, and secondly, for the inductive composition of theory to emanate from this meaning system. In effect, the researcher used it to analyse qualitative data through categorisation, generalisation or abstraction and then theoretical reflection. The researcher decided which aspects of the data were important, then coded and categorised them and lastly showed their relative connections through the formulation of a framework. This allowed the researcher to develop a theoretical understanding of the meaning system as it

allowed for hypotheses to emerge from the data in a field in which very little research had been done on this specific topic. To this end, the role of the researcher was central both as a contributor to knowledge and as a developer of some aspect of a theoretical frame of reference as she interpreted the meaning system and the hypotheses so generated and synthesised them into an emerging model of an ed tech coach.

One concern in the analysis of eLearning

One of the general concerns in the analysis of eLearning is the consideration of the relationship between teaching about technology and teaching with or through technology. It has been the central argument of this study that teaching with or through technology changes teachers' technological and pedagogical knowledge. The researcher has argued that it is specifically the case that ed tech coaches who help teachers to implement iPads and their affordances into their teaching change teachers' pedagogy and improve their teaching and their students' learning. It seems to be an inescapable conclusion that the role of ed tech coaches is necessarily crucial for the effective, co-ordinated and sustained implementation of the affordances of iPads in schools.

The significance of this finding lies with the conclusion that when these skilled practitioners work with iPads and the teachers' content knowledge they build the teachers' TPK and change their pedagogy for the better. Without their intervention teachers either do not use iPads in beneficial academic ways or do not use them in ways that improve their pedagogy. Teaching about how to use the iPad alone does not change pedagogy as all iPad users learn how to use it when they buy it, but this is not enough. Of all the technological innovations that teachers have used, the iPad could be the one that has heralded the most significant changes as it could allow teachers to improve their pedagogy and, importantly, allow students to use it in ways that make them at least as proficient as the teachers. In many cases it could be argued that students are more proficient than teachers, which is highly unlikely to have been the case with previous technological devices. None of the other technological innovations that teachers have adopted give teachers and students so much scope for learning on their own and for researching and presenting material in diverse ways with unrivalled levels of sophistication and ease. It permits a greater participative democracy in the classroom.

While the proposed model of an ed tech coach represents an ideal formulation of their role, it should not be regarded as a job description or a checklist of activities. Rather it should be seen as a compilation of attitudes and behaviours that engender

academically productive relationships between coaches, teachers, students and parents, in other words with all the stakeholders concerned with daily educational activities at schools.

As noted in the introduction, if no one is employed as an ed tech coach, then the functions of the role are most likely to be taken up by an interested teacher, as was the case with ETC3. However, at some point the demands of the ed tech role will conflict with the subject teaching demands and one of the roles will suffer. This is the time for principals to recognise the value of having a dedicated staff member to help others develop teachers' technological expertise through implementing iPads and their apps in a co-ordinated and sustained and so effective way rather than relying on this happening extemporaneously.

The affordances of iPads, as set out in the conceptual framework table, offer a synoptic view of the pedagogical affordances that ed tech coaches can use to develop TPK in teachers. While the ed tech coach might not teach all of them directly, through usage teachers could develop a deeper and broader understanding of how the device could be used. For example, it is unlikely that an ed tech coach would specifically and directly teach about the pedagogical affordances of ubiquitous, flexible and polysynchronous learning arising from the iPad's portability and size. However, it is likely that the coach would mention the pedagogical affordances listed in the table below, or that the teacher would discover them for him or herself.

Table 1 (repeated): A Conceptual Framework: Matching Some Specific iPad Capabilities to Some of its Technological Affordances and Pedagogical Affordances

IPad capability	Technological affordance	Pedagogical affordance
A) Size	Portability	Learning is ubiquitous, flexible, polysynchronous
B) Long battery life	No need for a power cable	Mobility of teachers and students, inside and outside of classroom
C) Touch screen	Direct interface	No mouse, no external keyboard or track pad Keys do not stick
D) Intuitive interface	Quick and easy to learn	Tap and swipe Teach with and through, not about, tech Student gurus Team-teaching and material development

E) Integrated audio and video	Make and play back audio and video recordings Access to worldwide resources	Movie or audio recordings Authentic learning Virtual stage Sophisticated presentations Written or spoken comments Teacher carries little home Flipped classroom Special needs learners Digital textbooks
F) Guided access	Temporarily restrict to single app Choose which app features are available Disable hardware buttons	Stay on task Disable task irrelevant screen areas Prevent accidental gesture distractions
G) Apps	Seamless integration	Document and resource sharing makes collaborative work easier Learner construction of material Heutagogy
H) Apple TV¹	Share screen of one iPad to whole class	Whole class sees peers' or teacher's work whether text, audio, or visual
I) Apple classroom¹	Monitor and manage iPads	Only teacher can see what each student is doing Teacher sends or receives work through any app to or from individuals Teacher corrections

These affordances undergird all the work that an ed tech coach does. Without having a coach to point them out and show how they can benefit a teacher's pedagogy, it seems unlikely that teachers would use them in their teaching, even if they understood theoretically how it would be possible to do so. This is not because the affordances are not adequately signalled or are inherently difficult to use but rather because teachers' time constraints inhibit comprehensive discovery and implementation. When an ed tech coach develops a relationship of trust with a teacher, it is more likely that he or she could hold that teacher accountable for continuing to attend sessions and for implementing the iPad and its apps in their teaching. As this study's findings show, this type of professional development yields effective, co-ordinated and sustained results.

A slightly scaled down version of the table summarising the findings and discussion of the role and focus areas of an ed tech coach as gathered from the data is reproduced below so that it is immediately available.

Table 6 (repeated): Summary of an ed tech coach's focus areas

CATEGORY	SUB-CATEGORY
Teacher-driven Scheduling	The teacher's needs and timetable ETC availability Approaching teachers
Relationships with Teachers	Feedback from teachers Individual meetings Relationships based on trust Working at the teacher's pace Giving some control to students Relieving teacher's perceived technological burdens Uncommon aspects of the ETC-teacher relationship Younger students' knowledge Working with reluctant teachers
Teacher-driven Agendas	School factors impinging on teacher-driven agendas Working with inexperienced, but motivated, teachers Working with experienced, motivated teachers Working the way the teacher wants to
ETC-driven Agendas	Providing feedback Providing backup Providing a learning management system for digital workflow Providing a range of apps Providing indirect help Providing for teacher growth Providing immersive experiences Providing an antidote to stagnation
Relationships with Parents	Security concerns Parental responsibilities around digital safety Improved digital safety outcomes Parental communication Parents helping with homework and studying Modelling ethical behaviour
Relationships with Students	Teaching with students' work Learning from students
Empowering Students	Allowing students to learn by doing Using technology to strengthen students' emotional connections to material Student-created resources Students solving technological problems Students as teachers of content Students as teachers of technology Students and copyright and plagiarism issues Students and icons Student learning and deadlines Student
Teachers' Relationships with Students	Teacher mobility Student independence Students trusting teachers Teacher comments Students' use of technology for their own purposes Developing student presentation skills Developing student opinion Authentic tasks Students learning from experts

	Students as teachers of content Students as teachers of technology
ETCs and Teachers Learning from Others	Ed tech coaches learning from teachers Teachers learning from students Ed tech coaches and teachers learning from their own children
Personal Professional Development	Learning from peers outside of school Learning from peers at school Learning alone Learning with your teacher in an iterative process

In developing teachers' TPK it seems likely that the DISA matrix, with its revealing of the relationships between instruction and the implementation of apps, correlates with the four levels it seems teachers generally might progress through: first level teachers might be characterised by dependent learning; second level teachers seem to progress to influenced learning; third level teachers might display serendipitous learning; fourth level teachers could be considered to exhibit autonomous learning. Table 2 is repeated to show the DISA matrix relationships between instruction and apps.

Table 2 (repeated): The DISA matrix showing relationships between instruction and apps

THE DISA MATRIX SHOWING THE RELATIONSHIPS	BUILT-IN APPS	PURCHASED APPS
DIRECT ED TECH COACH INSTRUCTION	1. Dependent Learning: The coach gives direct instruction to the teacher about the built-in apps and their affordances for teaching.	2. Influenced Learning: The coach gives direct instruction to the teacher about the affordances of purchased apps that the teacher will need to buy and download.
NO DIRECT ED TECH COACH INSTRUCTION	3. Serendipitous Learning: The teacher happens to discover an affordance of a built-in app that he or she has not been directly instructed in and applies it in his or her teaching.	4. Autonomous Learning: The purchases and downloads apps and applies their affordances in her teaching with no direct instruction by the coach.

Irrespective of the level a teacher could be considered to have attained, one of the most important qualifications for the coach to have is a deep-seated desire to be of help to all the stakeholders, even though the majority of their effort will be directed towards teachers. Often it is through the teachers that they then help the students and parents, but there are times and situations when direct help to these others is both appropriate and desirable. In short, the coach must build technological competence and confidence in a range of people journeying towards greater technological sophistication. Although this will be to meet the teachers' direct curriculum needs primarily, it could

also include helping teachers, for example, to use Twitter to connect with colleagues in local schools, or those further afield, or with experts outside of the school. Furthermore, it is not to be expected that everyone will proceed in lock step with everyone else. Uniformity of uptake is not the goal, rather, personal needs and interests develop the pathway that individuals travel.

Hallmarks of an ed tech coach's success

The emerging model of an ed tech coach point to three hallmarks of success; namely vision, escalation and critical mass. The first hallmark, vision, could arise when an individual teacher begins to see the possibilities available for using the iPad as one of the tools in his or her repertoire and tells the coach of this. It is not being suggested that iPads replace the teacher or any method of instruction. Teachers will know whether or not the use of an iPad or a particular app is appropriate in any situation, especially if they are under the guidance of an ed tech coach.

The second hallmark, escalation, might begin to occur when an individual the coach has helped then turns to help those who do not know what he or she does. This might entail showing colleagues, students or others, how to use a new app or aspects of an app of which they might be unaware. This does not imply that the helper knows more, but that he or she is willing to share experience and knowledge. This might lead to a powerful learning situation, as it is essentially a word of mouth recommendation from a trusted person as well as being a specific and targeted intervention that has the potential to directly satisfy an individual's needs.

The third hallmark, critical mass, could be manifest when someone asks for help because they saw the coach helping another person with something they thought they could also use. Once such a person has come forward, the coach might be able to help them with implementing the iPad in other ways as well. Often this indicates that individuals as yet 'uncoached' have begun to take notice of the work he or she has undertaken with others. This could be an important signal of the impact and reach of the coach. Ed tech coaches often start by helping an individual or department in one classroom or office. When others notice the effect of this it becomes a tacit acknowledgement of the traction the coach's work is gaining in embedding technology as a taken-for-granted part of school life rather than as needing to be added artificially to lessons, tasks or assessments.

The three hallmarks, vision, escalation and critical mass, can be summarised in

the fulfilment of the underlying principle of the proposed model of an ed tech coach: discovering how the teacher wants the iPad or app to change his or her pedagogy for the better. When the coach bases his or her work according to this principle, all the others flow from it: meeting the teacher's needs; knowledge of applications; collegiality; modelling desired behaviour and meeting the students' needs. When these principles are evident in an ed tech coach's work then teachers' pedagogy will be changed through the successful implementation of iPads.

Table 7 (repeated): Principles underlying an emerging model of an ed tech coach

Principles	Behaviours
Changing pedagogy	Discovering how the teacher wants the iPad or app to change his or her pedagogy for the better • Reimagining changing pedagogy • Slowly changing pedagogy • Radically changing pedagogy • Co-operatively changing pedagogy
Meeting the teacher's needs	Working with teachers at any of the four levels of competence
Knowledge of applications	• Knowledge of evergreen, multifunctional or creative apps • Trialling and testing apps • Deciding on student purchases • Teaching about the iPad and an app
Collegiality	Sharing with other ed tech coaches Sharing with teachers within and between departments Sharing with colleagues and teachers outside of school
Modelling desired behaviour	To teachers and students
Meeting the students' needs	• Re-teaching app functionality • Suggesting other apps or ways of meeting task requirements

This summary of the proposed model of an ed tech coach offers more detail about key findings. It also brings to the fore other areas that could contribute to further discoveries in this field.

Possible areas for further research

This study focused on the implementation of the affordances of iPads by ed tech coaches in one large, not-for-profit, private school. This was done for three reasons: logistical convenience as the researcher was employed by the school; to keep the scope of a PhD study manageable; and to avoid any possible obfuscation or entanglement that studying both public and private schools, or using more than one brand of device, might have had on the analysis and findings. It would be of interest to see if these findings hold in schools in which non-iPad tablets are used and which also have an ed tech coach

on the staff. In methodological terms a qualitative study could test the hypothesis that it is the work of an ed tech coach that is the key element in changing teachers' pedagogy when tablets are used in the classroom. This could be achieved through the administration of a semi-formal, standardised questionnaire developed from the background and specific questionnaires used in this study. This would enable a direct comparison to test the validity of the findings of this study.

Another avenue of possible further investigation relates to the South African government's 2030 National Development Plan. The goal of the Phakisa project is to focus on education, especially on the role of ICTs in education. While it is tempting for politicians to earmark large sums of money from the national purse to spend in developing greater technological uptake in schools, it would be disastrous to do so without sober consideration of the possible pitfalls. The researcher would suggest that going to the expense of training an ed tech coach for each school might be a helpful adjunct to such a programme, but further investigation would be needed. In this regard the principles mentioned in this study could serve as a starting point for the development of such a course, if the principles were first tested in public schools with non-iPad devices.

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