A Conceptual Understanding of how Educational Technology Coaches help Teachers Integrate iPad Affordances into their Teaching

Gail Drennan and Ian Moll
School of Education, University of the Witwatersrand, Johannesburg
Gail.drennan1@gmail.com
ian.moll@wits.ac.za

Abstract: Educational technology (ed tech) coaches can help teachers and students integrate iPad affordances into their teaching and learning. A brief overview of affordance theory is provided. While investigating the under-researched practices of ed tech coaches, the authors identified iPad affordances and tabulated these, revealing links between the iPad's technological capabilities, technological affordances and pedagogical affordances. Nine iPad technological capabilities, such as the camera, were aligned with some of their technological affordances, such as taking a photo. These were matched to some pedagogical affordances, such as taking a photo for educational purposes. Finally, different categories in the table were combined into six broad strands unveiling how ed tech coaches use them to change teacher pedagogy with benefits for teachers, students and parents. Ed tech coaches often naturally build teachers' TPACK, mostly through the SAMR model. Specifically, they change teachers' pedagogy by focusing on polysynchronous teaching and learning; digital, transformed learning; student ownership of learning with teachers as facilitators; students as teachers of content and technology; teachers' triple agendas of content elaboration, academic argument, and digital citizenship; and student creativity.

Keywords: iPads, affordances, ed tech coaches, TPACK, SAMR.

This paper draws conclusions from a descriptive analysis of a literature review on the affordances of iPads. It is rooted in research considering the role of educational technology (ed tech) coaches in helping teachers to use these affordances and the resultant pedagogical changes, as this was not researched previously. The research, underpinned by grounded theory, garnered data about ed tech coach practices and resultant teacher pedagogical changes. These were drawn from voice recordings of interviews with and observations of five ed tech coach and five teachers they supported. After transcription and analysis by the researcher, the findings were developed into a proposed model of an ed tech coach. The research was informed by Mishra, Koehler and Cain's (2013) Technological Pedagogical Content Knowledge Framework (TPACK) and Puentedura's (2014) Substitution Augmentation Modification Redefinition (SAMR) model. TPACK contextualized the researcher's understanding of what the coaches wanted to achieve, while the SAMR model gave insight into how they helped teachers change their pedagogy.

As will become apparent, the literature on educational tablet use concentrated on affordances and applications (apps) available for teaching. iPad research has shown that the access-to-resources barrier may have been reduced and technological integration eased (Jodoin, 2013). Less has been written about how teachers' pedagogy might have changed. While Valstad and Rydland (2010) decried leaving iPad integration to individual teachers, Nguyen, Barton and Nguyen (2014) communicated the concomitant need for suggestions to adapt pedagogy. Reid and Ostashewski (2011) revealed an early pedagogical change when record-and-play video functionality demonstrated Ukrainian dance movements with students controlling devices.

We review affordance literature and then postulate conceptual links between the iPad's technological capabilities that create technological affordances leading to pedagogical affordances. Technological capabilities can be defined as the hardware and software elements of the physical iPad and its applications. An example of both elements would be the physical camera and its operating software. Technological affordances can be defined as the use of technological capabilities, for example, using the camera to take a photo. Pedagogical affordances can be defined as the use of technological affordances for pedagogical purposes, such as using a photo to elucidate an educational concept. We articulate specific examples of these concepts, clarifying their relationships. We discuss the pedagogical affordances as six broad strands illustrating how teachers' pedagogy can change, when filtered through the TPACK and SAMR models, giving specific benefits

for teachers, students and parents. This conceptual understanding of iPad classroom usage rebuts Murray and Olcese's (2011) assertion that such technological usage supports behaviourist or early cognitive positions.

The paper is structured as follows. Affordance theory briefly provides context, then pre-tablet Information and Communication Technologies' (ICTs') educational affordances are discussed. Thereafter tablet affordances are explained, followed by a table linking nine iPad technological capabilities to their technological affordances, and some of their pedagogical affordances. Subsequently, a theoretical conception of six ways in which iPad technological affordances can create new pedagogical affordances, and change pedagogy, is provided. The conclusion is advanced that teachers can change their pedagogy through using these relationships to develop their TPACK, especially through the SAMR model, with six advantages for teachers, students, and parents.

1.   A Brief Overview of the Foundations of Affordance Theory

Gaver's (1991) work, on the importance of affordance signalling in design, accentuated the alignment of intended and actual use to make tools easy to use. Norman (1999) characterised affordances as embodying possible interconnections between actors and objects, focusing on the actor's intentions and tool design as driving affordance perceptions (McGrenere & Ho, 2000). However, Hammond (2010) asserted we see affordances through interactions with objects, while Gibson (2014) held our affordance perception revealed our self-perception; both authors concentrated on actors and actions. Greeno (1994) and McGrenere and Ho (2000) articulated this as the confluence of the indissoluble actor-environment relationship. They agree with Gaver (1991) that affordances are actor-independent, but usability depends on an actor's knowledge, experience, and culture. We include social identity and purpose, as Rietveld and Kiverstein (2014) argue affordances are embedded in socio-cultural practices, dependent on specific contexts and skill levels. Orlikowski (2007) refers to this user-affordance nexus as constitutive entanglement.

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 learning different ways symbols are signalled. Kennewell (2001) advances Greeno's (1994) and Hammond's (2010) postulation of constraints as being the obverse of affordances, asserting that affordances provide action through constraints that provide structure. Nevertheless, Kennewell (2001) observed ICTs having peculiar classroom affordances, being dependent on other classroom variables.

2.   Affordances of Pre-tablet ICTs in Education

Conole and Dyke's (2004) pre-tablet work drew on early iterations of online tools. They attended to affordance expression, their compilation in an ITC taxonomy, and educational applications, listing ten beneficial areas for teachers' pedagogy, and organizational changes necessary to accommodate these. We argue that three (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 disregard teachers' pedagogical change.

Before tablets and dependent on school resources, teachers and students could use desktop and laptop computers in computer laboratories, mobile phones, games consoles, MP3 players, digital cameras, interactive whiteboards and iPod Touches (Department of Education and Early Childhood Development, 2008). In weekly lessons, students learnt word processing skills (see Department for Education and Skills, Abbott, Webb, Blakeley, Beauchamp, & Rhodes, 2003), or did mathematics drills. Department for Education and Skills (2003) and Sampson et al. (2013) bemoaned computer-connected interactive whiteboards being teacher controlled, used solely as electronic chalkboards. Agostini and Di Biase (2012) noted using interactive devices in primary classrooms resulted in deeper communication and involvement. Similarly, Caldwell (2007) observed increased engagement and feedback when clickers (classroom response systems) polled students anonymously.

Before tablets, iPod Touches afforded the greatest teacher and student interactivity, allowing for easier presentation of audio and visual material (Reid and Ostashewski, 2011). In 2009, Hayward School, now Essa Academy, in Bolton, England, gave each student an iPod Touch (Innovate my School, 2012). From the first year, it was considered a major trigger in turning the school's failing results around as the Wi-Fi-enabled devices allowed direct access to teacher-created podcasts, educational and gaming apps and the Internet. Innovate my

School (2012) detailed they were used to make notes, email work, complete administrative tasks and exam revision. Furthermore, Innovate my School (2012) divulged with their large refugee population and dozens of mother tongues, the dictionary and thesaurus apps improved students' English without their leaving class to attend language lessons and they read Wikipedia in their home language to understand topic basics. Subject-specific apps, such as *Shakespearean Insults* [original emphasis] and *Elements* [original emphasis] enabled teachers to present English and chemistry material in engaging ways. Moreover, Innovate my School (2012) disclosed the devices helped technophobic teachers and boosted student self-worth. This could lead to students influencing teachers, even changing their pedagogy and is discussed later. Compared to other devices, the iPod Touch allowed for the greatest interactivity and flexibility between teachers and students, foreshadowing the introduction of tablets.

3. Tablet Affordances in Education

The early literature did not deeply examine general tablet affordances, as most dealt with iPads only. Nguyen, Barton, and Nguyen (2015) describe this early, extensive iPad adoption by younger students and academics. 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-centred learning; use of e-books; resource saving; flexibility in time and place; eco-friendliness; and resource competitiveness. We consider the first five the more important as they directly impact teachers and students.

However, when teachers and students, used to non-Apple operating systems, change their paradigm and engage with iPads, they appreciate its intuitive design, high levels of usability, and the glitch-free switching between applications (Golland, 2011). One major affordance, video capability, can increase social capital (Quidwai and Norman, 2016). They 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 improved student empathy. They were sensitised to challenges facing those dependent on state-provided health care and to their interactions with people from varying backgrounds. The fuller implications of affordances on teachers' pedagogy are discussed later.

Haßler, Major, and Hennessy (2016) considered all tablet brands in reviewing evidence on students' learning outcomes. They found support for teachers positively changing group discussions and learning outcomes through using tablets in many-to-one situations. Teachers' transformed pedagogy resulted in improved end products when compared to the interaction and group communication of one-to-one situations. Herodotou (2017) examined how young children used non-iPad tablets without mentioning specific device affordances. Lazarus, Sookrajh and Satyapal (2017) examined second year South African medical students' engagement with non-iPad tablets and their associated affordances and challenges. Semmelmann, et al. (2017) mentioned mobility, cost and implementation of tablet affordances as facilitating developmental psychological research with young children, some of which might apply to educational settings. Traxler (2010) warned about quality assurance difficulties educational providers, especially universities, could face. He cited a pilot study showing students were unlikely to use devices provided for them by institutions if these were not aligned with devices students wanted to use. In a school, however, tablet standardization might prevent stakeholders having to cope with several operating systems as could happen under a Bring Your Own Device policy.

4. iPad Affordances in Education

National Association of Advisors for Computers in Education (NAACE) (2012) noted the dominance and educational value of the iPad, when compared to Android devices, because of the reliable operating system, interface and the numerous educational apps. Reed (2013) considered the iPad's reliability as giving it frontrunner significance in technological innovation and ubiquity. Compared to other tablets, Meyer (2013) affirmed iPads' lower maintenance costs. Clarke and Abbott (2016) reiterated Copeland's observation that iPad ICT skills could be learnt without formal teaching. This impacts pedagogy as it relieves teachers of a significant technical burden, ensuring teaching and learning continue uninterrupted.

Lane (2012) oriented iPads as unitary devices with an array of modalities suitable for researchers, teachers, students and others. Valstad and Rydland (2010) align this with the modality principle that multimedia, not visual, presentation results in better learning. Karsenti and Fievez's (2013) comprehensive survey enumerated

16 main benefits for students using iPads, including more diverse pedagogy. Clarke and Abbott (2016) endorsed the benefits of iPad apps reinforcing traditional pedagogy. Cochrane, Narayan, and Oldfield (2011) furnish details of links between iPad capabilities, social constructivist pedagogy, and the application of affordances for diverse tertiary students.

5. 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, such as size, touch screen, battery life, and camera; as well as installed software apps such as email, web browser, calendar, and the note, slide and video-making programmes. (Apple Inc., 2018) Technological capabilities become technological affordances when they are used; for example, using the camera to take photos or videos. The pedagogical affordances refer to the way teachers and students use the technological affordances to meet educational goals. The camera (technological capability) might be used to take a photo (technological affordance) of a flower to record its beauty. It might be used (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 its categorisation as a pedagogical affordance. We turn to a tabulated description giving specific examples of these concepts to clarify some of their relationships.

Table 1 matches some of the iPad's capabilities to some of its technological and pedagogical affordances. The authors divided the affordances of iPads into three underlying physical, software and connectivity capabilities (first column in the table). These give rise to technological affordances (second column). Finally, some of the resultant pedagogical affordances are listed (third column). We cannot match all iPad capabilities with all their technological affordances and pedagogical affordances, as coaches, teachers and students are endlessly creative, so no exhaustive listing of them would be possible. We categorise some of the obvious ones and the relationships between them. The discussion mentions some linkages with the TPACK and SAMR models.

Table 1: Matching Some Specific iPad Capabilities to Some of their Technological Affordances and Pedagogical Affordances.

IPAD CAPABILITY	TECHNOLOGICAL AFFORDANCE	PEDAGOGICAL AFFORDANCE
1) Size (physical capability)	Portability	Learning is ubiquitous, flexible, polysynchronous (not time bound)
2) Long battery life (physical capability)	No power cable needed	Teacher and student mobility, inside and outside of classrooms
3) Touch screen (software capability)	Direct interface	No mouse, no external keyboard, no track pad Keys do not stick
4) Intuitive interface (software capability)	Quick and easy to learn	Tap and swipe Teach with and through, not about, tech Student gurus Team-teaching and material development
5) Integrated audio and video (software capability)	Take 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 (content covered outside school, understanding checked at school, reversing traditional classwork and homework) Special needs learners Digital textbooks
6) Guided access (software capability)	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
7) Apps (software capability)	Seamless integration	Document and resource sharing eases collaborative work Learner material construction Heutagogy
8) Apple TV[1] (connectivity capability)	Share one iPad screen to whole class	Whole class sees peers' or teacher's work
9) Apple Classroom[1] (connectivity capability)	Monitor and manage iPads	Only teacher sees each student's work Teacher sends/receives work through any app to/from individuals Teacher corrections

[1]Apple TV and Apple Classroom recall one teacher giving differentiated learning to a class at one time through a teaching machine (Spark & Sackstein, 2014) but does not support a behaviourist perspective, as using either reformulates the teaching machine idea.

The table is more fully explained as six strands in which teachers' pedagogy can change, sometimes when filtered through TPACK and SAMR models. Each strand gives detailed examples from the point of view of different school stakeholders; teachers, students and parents.

6. 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 latter is not discussed here, the rest can change pedagogy, as raised by State of New South Wales (2012), and strengthen TPACK (Koehler, Mishra and Cain, 2013). 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 leading to passive consumption of texts, videos, and games (see The Learning Exchange, 2011).

Students are unlikely to achieve these skills unless teachers deliberately integrate them into their teaching (see Attard, 2013; Geer, White, Zeegers, Au, and Barnes, 2015; Krauskopf, Zahn, and Hesse, 2012; Lange and Meaney, 2013; McFarlane, 2013; and Spark and Sackstein, 2015). Rockman declared pedagogy trumps anything (Cuban, 1993, see also Joy and Garcia, 2000; Seau Yoon, Ho and Hedberg, 2004). Sackstein (2014) contrasted the contexts of product and idea technology. Warringa Park School (2013) concurred that iPads support, not replace, good teaching.

Technology does not teach, teachers do. How can teachers change their pedagogy and use iPads in their teaching? They must adapt and learn continually themselves (Darling-Hammond, 2006). They must lead the change and model iPad use (Bansavich, 2010, and Nguyen, Barton and Nguyen, 2014). Staff training and collaboration time with digital mentors, such as ed tech coaches, is crucial Cowan and Earls (2016).

How can ed tech coaches help teachers change their pedagogy? We present six ways coaches can use the iPad's technological capabilities and technological affordances to create new pedagogical affordances teachers can implement, often using SAMR to develop teachers' TPACK. Now, the nine technological capabilities listed in Table 1, their associated technological affordances and their most pertinent pedagogical affordances, are amplified.

6.1 Polysynchronous Teaching and Learning

Here we turn to the affordances of the iPad's size, battery, screen, interface, audio/visual and apps. Polysynchronous teaching and learning is not necessarily bound by time and space. It can happen synchronously or asynchronously in the classroom or online (see New Media Consortium, 2016). Firstly, pedagogy changes when the iPad is used as an all-in-one device, meeting SAMR's Redfinition requirements. Students complete all aspects of different tasks using the iPad only (see Warringa Park School, 2013). Secondly, students receive tasks electronically, find online resources, complete the task through an appropriate app, submit completed digital work, and receive written or verbal comments digitally. Class-facing boards, printing or photocopying machines, even stationery becomes irrelevant. Through condensing teaching functions in time and space, the iPad simplifies and extends teacher and student capability, fulfilling Cuban's (1993) promise of productivity, and meeting Murray and Olcese's (2011) technological significance criterion that users become more productive. Polysynchronicity could ensure uninterrupted teaching and learning. Teachers and students need not inhabit the same physical classroom at the same time. Moving away from industrial era school models (State of New South Wales, 2012), extends times and spaces where learning occurs (Warringa Park School, 2013), effecting Brand and Kinash's (2010) prescience of anywhere and anytime education. NAACE (2012) claims easier access to resources through reduced effort, time and travel costs, with concomitant efficacy. Souleles, et al. (2015) assert proactive art and design students working in digital media benefit when time and space constraints are removed.

Polysynchronicity advances two pedagogical changes. Firstly, teachers assimilate their TPACK when giving 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) construes this remediation as in-class

differentiation. Cuban (1993) foreshadowed this as students receiving personal instruction without the teacher being present. This flipped classroom pedagogy enables students to view the material as often as they need, privately, without publically indicating their lack of full understanding the first time, and it enables students to review material as needed before assessment. The New Media Consortium (2016) revealed significant student gains with this blended method. Student metacognition increases with awareness of differences in thinking between first and last viewings as Kolb's experiential learning theory applies (Healey & Jenkins, 2000).

Secondly, remote contact and productive work remains possible when staff or students are absent or apart. Students submit completed work and teachers their marking when they are finished, not when they next see each other. Students develop independence when iPads are used thus (Reid and Ostashewski, 2011). With Innovate my School (2012) and Sampson et al. (2013) they reflect on the reciprocity digital contact gives students and teachers, through increased communication, support and enhanced relationships (see also Faris and Selber, 2013; Khoo, et al.,2013). Time and place do not limit teachers or students as ubiquitous, mobile, flexible, and polysynchronous learning becomes a reality.

Polysynchronicity can relieve parent concerns about children missing teaching and learning. The iPad is the device through which work is given, done, 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 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, such as Khan Academy, Harvard University, or anyone choosing to make videos available online.

6.2 Digitised, Enhanced Learning Compared to Digital, Transformed Learning

Now the affordances of the iPad's screen, interface, audio/visual, apps, Apple TV and Apple Classroom are applicable. The iPad changes pedagogy if tasks fulfil the Modification and Redefinition criteria of the SAMR model (Puentedura, 2013). 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. The difference lies in the degree of technological engagement. Ed tech coaches sometimes take teachers through the SAMR model steps to increase their confidence. This can be exemplified through a teacher setting an essay task.

6.2.1   *Enhanced or digitised tasks*

Enhanced or digitised tasks are Substitution tasks; they are paper-under-glass tasks such as writing an essay using a word processing app rather than handwriting it. Teachers' TPK slightly increases as they must scan and upload tasks. This level of technological engagement does not increase conceptual engagement. Presentation, not thinking has improved. Thinking, not typing, is important. Augmentation allows wider functionality such as using different fonts. Teachers' TPK is moderately increased as the iPad allows for word processing, but this is not transformative engagement. In contrast, transformative or digital tasks require students to engage with the iPad in significantly different ways that extend their capability, allowing them to do things otherwise impossible.

6.2.2   *Transformative or digital tasks*

For an essay to qualify as Modification students share essays digitally, perhaps through a class blog or wiki. This improves teachers' TPK as they set up the platform and its parameters. It changes how students think about the essay, keeping in mind the larger peer audience, who may be more critical in online comments than the teacher. Sharing with wider audiences could develop authenticity as interested, expert adults might read the essay rather than the teacher only (Zielezinski, 2017). Learning from others globally expands nuanced understandings of cultural contexts beyond one's own (Deinhammer, 2016). Teacher-digital sharing encourages active dialogue with colleague communities (Harris, Mishra and Koehler, 2009).

Finally, using the iPad to create, film, and edit a video based on the essay exemplifies Redefinition as teachers' TPCK coalesce in task and rubric design. The pedagogical purpose of the essay is changed. Students think about their writing in more visual terms as the process is geared towards a visual product.

These examples show teachers and students engaging with technology in substantially different ways and greater student creativity is often displayed. Both extend their capability through modifying the process and

product of their thinking, with changed pedagogy redefining and transforming the task, so it could be completed only digitally on the iPad. Before iPads, these tasks were not possible using one device only.

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 (Warringa Park School, 2013). Parents can see their children working in ways that are familiar to them from their own working lives.

7.   Student Ownership of Learning with Teachers as Facilitators

Next, the affordances of the iPad's battery, screen, interface, audio/visual, guided access, apps, Apple TV and Apple Classroom are pertinent. Pedagogy changes if students have opportunities to own their learning more directly than studying for tests and examinations allows (Churchill, Fox and King, 2012). Oakley, et al. (2012) mention co-operative reciprocity between teachers and students. Clarke and Abbott (2016) informed on differentiated teaching amongst the young or less able students. Similarly, Warringa Park School (2013) linked iPad control to learning control, in a special school setting, while they, and Reed (2013), linked student ownership of learning with higher creativity. This seems to occur when teachers change from show-and-tell pedagogy to facilitating learning by providing structures and formats for learners to find, integrate, apply, and present information by themselves, meeting SAMR's Redefinition terms. Reichert (2016) formulates this in terms of students focusing on learning, rather than on teachers' teaching. Comparably, Sackstein (2014) clearly expounds on performance and competence pedagogic modalities. Students working independently, in groups, or as a class epitomise competence pedagogies (Burden, et al., 2012). When teachers facilitate the context, students engage increasingly actively with material to construct meaning (Spark and Sackstein, 2014).

iPads and their apps can be used in the same way, at the same level, by teachers or students, increasing their versatility. When teachers and students have equal access to resources Cochrane et al., (2011) appreciated the resultant collaboration and materials development, with students especially being creative. (Maher, 2013) and Reichert (2016) accentuated app multifunctionality enabling integration at any level in any field, when compared to more limited and limiting task-specific apps. The New Media Consortium (2016) explain this vanguard development as evidence of student-centric experiences promoting deeper learning, leading to changes in tertiary education, with academics as guides in online and blended learning, enabling student ownership of lifelong learning.

Aspects of the TPACK and SAMR categories can be reflected in one task with students taking ownership of their learning when teachers facilitate. Teachers might progress sequentially through the SAMR model, as they develop their TPACK, but not necessarily so (Geer, et al., 2015). An earlier stage (substitution or augmentation) may be relevant even when teachers are more experienced in modifying and redefining their tasks. If a teacher wants each student to research one aspect of the causes of World War I, and present this, the following might transpire. Task requirements are written up in Pages (Substitution). This is emailed to students (Augmentation). Students insert text, images or videos into individual Book Creator books (Modification). Students combine their books into one digitally shared Book Creator book (Redefinition). The teacher has facilitated student ownership of their learning through supplying detailed task information and rubrics. Empowered students gather information and compile their presentations..Throughout, the teacher has used TPK (knowing the technological demands matched the pedagogy), TCK (developing the rubric) and PCK (deciding on the task), revealing TPACK integration.

Parents can become aware of children working in sophisticated, complex, and collaborative ways. Students are more willing to discuss schoolwork with parents (Burden, et al., 2012), increasing their role in their child's education, and strengthening school-home relationships (Warringa Park School, 2013). Students mature as they take more responsibility for their learning, with possible positive impacts on entering tertiary education more able to study independently.

8.   Students as Teachers of Content and Technology

Now we consider the affordances of the iPad's size, screen, interface, audio/visual, guided access, apps, Apple TV and Apple Classroom. Digital sharing can change pedagogy, meeting SAMR's Modification specifications, as it has wider implications than students sharing 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)

designated students as peer teachers. State of New South Wales (2012) postulated content creation apps allowed a deeper educational impact than task-specific apps. As mentioned previously, 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. This might involve teaching about content directly, but also about technology indirectly. They might teach about the content and format of their presentation, as not all students will use technological affordances in the same pedagogic ways. Students seem to readily experiment with different ways of being creative. Similarly, Laurillard (2000) calls attention to the reality that student interpretation and app usage depends on context. If work is done at home, then students might also be responsible for teaching their friends, siblings, and even parents. Warringa Park School (2013) expanded on this.

9. Teachers' Triple Agendas of Content Elaboration, Academic Argument, and Digital Citizenship

Here the spotlight is on the affordances of the iPad's interface, audio/visual, guided access, apps and Apple Classroom. It seems that teachers follow two agendas, content elaboration and its academic realization. They discuss what proof or evidence reveals good thinking and acceptable argument academically through the content of their subject. iPads can change teachers' pedagogy, allowing the addition of a third agenda, good digital citizenship, as the iPad enables teachers to develop and enrich their TPACK.

This changes pedagogy in two ways. Firstly, teachers must teach good digital citizenship, especially plagiarism and referencing, because of fingertip access to global online resources in different formats, as well as access speed (see Oakley, et al., 2012). Secondly, iPads remove the need to collect and store physical resources. Teachers can direct younger students to digital resources from an online, curated range, or older students to digital resources from the spectrum of opinion and thought within that subject. Instead of solely seeking inspiration through teacher presentations, student creativity can flourish when they are exposed to diversly formulated materials, meeting SAMR's Modification and Redefinition conditions. With easy Internet access teachers are not knowledge gatekeepers. Their responsibility lies in applying digital citizenship in and through their subject, and by using sources ethically and appropriately themselves. Cut-and-paste plagiarism and superficial resource use hinders academic depth of argument. Teachers must set tasks needing academic argument construction and support. When students take digital citizenship seriously, their intellectual honesty raises the levels of awareness around integrity, scepticism, and personal accountability, benefitting parents and wider society.

10. Student Creativity

Lastly, we evaluate the affordances of the iPad's size, battery, screen, interface, audio/visual, apps, Apple TV and Apple Classroom. Blackwell (2014) commented that easy and quick access to resources enabled greater levels of student creativity resulting in more sophisticated products, even in early childhood education classrooms. Karsenti and Fievez (2013) accentuated the improved quality and creativity of presentations, in line with SAMR's Augmentation and Redefinition proposals.

Maher (2013) framed multimodal resources as allowing individual ways of achieving the same end. Students can use more media in more ways to create powerful pieces of work; pasting paper onto cardboard is no longer the sole creative outlet. Students can be given tasks requiring 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 with a printed picture of Hitler and 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 is a time-length or a data-size limit to the task, students must decide about the relevance and appropriateness of different videos. Previously this was the teacher's responsibility. 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 to it. Students who read a textbook only have an 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 audience responses.

Teachers would 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) accentuated the exploratory and collaborative interactivity of students and teachers learning together. This partially solves the problem of teachers unable to envision collaborative tasks (Sackstein, 2014), as does Nguyen, Barton and Nguyen's (2014) reminder that social apps can foster academics' collaboration. Moreover, students can help their parents improve their own work presentations or use their creativity to explore different hobbies or careers.

11. Conclusion

This paper argued that the iPad's technological capabilities create technological affordances that can lead to the development of new pedagogical affordances. Firstly, nine specific examples of the concepts were tabulated to clarify some relationships. Secondly, the pedagogical affordances were discussed through six broad strands illustrating how teachers' pedagogy can change. Each discussion lists specific benefits for teachers, students, and parents.

The iPad's technological affordances give six ways for teachers to transform their pedagogy. Firstly, polysynchronous teaching and learning allows for face-to-face, synchronous and asynchronous education; for teaching to occur in different places at the same time; for students to repeatedly review material at their convenience; for increased student metacognition; and for students to submit work upon completion. This ensures uninterrupted education, as one-time, face-to-face teaching is not the norm, and parents know that education is always accessible for their children. Secondly, digital, transformed learning alters the process and product for students, extending their creativity and capabilities and bringing them closer to adult working life. Thirdly, when teachers allow students to own their learning, this extra responsibility matures them, enabling independent, lifelong learning. Fourthly, empowered and confident students teach themselves, their peers, friends, and family members. Fifthly, teachers who teach digitally raise academic integrity in students. Sixthly, teachers develop creative and academically confident students when they research topics of their choosing, in formats of their choosing.

There are clear relationships between the iPad's technological capabilities, its technological affordances, and the pedagogical affordances these allow. Ed tech coaches can use them to develop their teachers' TPACK, especially when using the SAMR model. Moreover, there are six ways teachers can transform their pedagogy and benefit their students.

References

Agostini, A. and Di Biase, E., 2012. Large multi-touch screens to enhance collaboration in the classroom of the 21st century: an Italian experiment. *Interaction Design and Architecture(s) Journal*, 15, pp.40–56.

Apple Inc., 2018. *iPad 4th generation – technical specifications*. [online] Available at: https://support.apple.com/kb/SP662?locale=en_US [Accessed 27 October 2018].

Attard, C., 2013. Introducing iPads into primary mathematics pedagogies: An exploration of two teachers' experiences. In: V. Steinle, L. Ball and C. Bardini (eds), Mathematics education: yesterday, today and tomorrow (Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia.) Melbourne, Australia, 7-11 July 2013. Melbourne: Mathematics Education Research Group of Australia.

Attard, C. and Curry, C., 2012. Exploring the use of iPads to engage young students with mathematics. In: J. Dindyal, L.P. Cheng and S.F. Ng (eds), Mathematics education: expanding horizons (Proceedings of the 35th annual conference of the Mathematics Education Research Group of Australasia.) Singapore, 2-6 July 2012. Singapore: Mathematics Education Research Group of Australia.

Bansavich, J.C., 2011. *iPad study at USF: June-December, 2010*. [pdf] San Francisco: University of San Francisco. Available at https://studylib.net/doc/14583351/ipad-study-at-usf.pdf [Accessed 13 April 2016].

Blackwell, C., 2013. Teacher practices with mobile technology: integrating tablet computers into the early childhood classroom. *Journal of Education Research*, 7(4), pp.1–25.

Brand, J. and Kinash, S. (2010). Pad-agogy: A quasi-experimental and ethnographic pilot test of the iPad in a blended mobile learning environment. In C.H. Steel, M.J. Keppell, P. Gerbic and S. Housego, eds. *Curriculum, technology and transformation for an unknown future. Proceedings ASCILITE.* Sydney, Australia, 1-4 December 2010. Sydney: ASCILITE.

Burden, K., Hopkins, P., Male, T., Martin, S. and Trala, C., 2012. iPad Scotland evaluation. *University of Hull* [pdf] pp.1-116. http://dx.doi.org.1-.13140/2.1.3593.5363

Caldwell, J.E., 2007. Clickers in the Large Classroom: Current Research and Bet-Practice Tips. *CBE-Life Sciences Education,* [e-journal] 6(1), pp.9-20. https://doi.org/10/1187/cbe.06-12-0205

Churchill, D., Fox, B. and King, M., 2012. Study of affordances of iPads and teachers' private theories. *International Journal of Information and Education Technology*, 2(3), pp.251-254.

Clarke, L. and Abbott, L., 2016. Young pupils', their teacher's and classroom assistants' experiences of iPads in a Northern Ireland school: "Four and five years old, who would have thought they could do that?" *British Journal of Educational Technology*, 4*7*(6), pp.1051–1064.

Cochrane, T., Narayan, V. and Oldfield, J., 2013. iPadagogy: appropriating the iPad within pedagogical contexts. *International Journal of Mobile Learning and Organisation*, 7(1), pp.48-65.

Conole, G. and Dyke, M., 2004. What are the affordances of information and communication technologies? *Research in Learning Technology* [e-journal] 12(2), pp.113-124. https://doi.org/10.3402/rlt.v12i2.11246.

Cowan, P. and Earls, J., 2016. Using the technology acceptance model to determine teachers' attitudes towards the introduction of iPads in the classroom. In: Proceedings of EdMedia 2016-World conference on educational media and technology. Vancouver: Canada, 28-30 June 2016. Waynesville: Association for the Advancement of Computing in Education. .

Cuban, L., 1993, Computers meet classroom: classroom wins. *Teachers College Record*, 95(2), pp.185-210.

Darling-Hammond, L., 2006. Constructing 21st-century teacher education. *Journal of Teacher Education*, 57(3), pp.300–314.

Deinhammer, J., 2016..5 ways iPads have changed the classroom. DailyGenius.com, [blog] 6 October. Available at: http://daily genius.com/5-ways-ipads-changed-classroom/ [Accessed 25 October 2016].

Department of Education and Early Childhood Development, 2008. *iPod Touch Research Report*. [online] Available at https://www.education.vic.gov.au/Documents/school/teachers/teachingresources/interdisciplinary/ict/ipodresearch.pdf [Accessed 23 October 2018].

Department for Education and Skills, 2003. *ICT and attainment: a review of the research literature*. London: Department for Education and Skills.

Faris, M.J. and Selber, S.A., 2013. iPads in the technical communication classroom: An empirical study of technology integration and use. *Journal of Business and Technical Communication*, 27(4), pp.359-408.

Gaver, W.W., 1991. Technology affordances. In: SIGCHI (Special Interest Group on Computer-Human Interactions). *Proceedings of the SIGCHI conference on human factors in computing systems. New Orleans, United States of America, 27 April-2 May, 1991. New York: Association for Computing Machinery.*

Geer, R., White, B., Zeegers, Y., Au, W. and Barnes, A., 2017. Emerging pedagogies for the use of iPads in schools. *British Journal of Educational Technology*, 48(2), pp.490-498.

Gibson, J.J., 2014. *The ecological approach to visual perception.* London: Psychology Press.

Godsk, M., 2013. Tablets for learning in higher education: the top 10 affordances. In: J. Sanchez and K. Zhang, [eds], Proceedings of *E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education*. Orlando: United States of America, 18-24 October 2013. Chesapeake: Association for the Advancement of Computing in Education..

Golland, B., 2011. *Affordances of iPads for improvement of learning outcomes and engagement in an ESL classroom* MA. University of Manchester.

Greeno, J.G., 1994. Gibson's affordances. *Psychological Review,* 101(2), pp.336-342.

Hammond, M., 2010. What is an affordance and can it help us understand the use of ICT in education? *Education and Information Technologies*, 15(3), pp.205-217.

Harris, J., Mishra, P. and Koehler, M., 2009. Teachers' technological pedagogical content knowledge and learning activity types: curriculum-based technology integration reframed. *Journal of Research on Technology in Education*, 41(4), pp.393-416.

Haßler, B., Major, L. and Hennessy, S., 2016. Tablet use in schools: A critical review of the evidence for learning outcomes. *Journal of Computer Assisted Learning*, 32(2), pp.139-156.

Healey, M. and Jenkins, A., 2000. Kolb's experiential learning theory and its application in geography in higher education. *Journal of Geography*, 99(5), pp.185-195.

Herodotou, C. (2017) Young children and tablets: a systematic review of effects of learning and development. *Journal of Computer Assisted Learning*, [e-journal] 34(2), pp.1-9. http://dx.doi.org/10.1111/jcal.12220.

Innovate My School, 2003. [Case study] iPods and apps at Essa Academy. [online] Available at http://www.innovatemyschool.com/ideas/case-study-ipods-and-apps-at-essa-academy [Accessed 19 July 2017].

Jodoin, T., 2013. *The effects of the use of iPads in secondary physical education.* MEd.University of Ontario..

Joy, E.H. and Garcia, F.E., 2000. Measuring learning effectiveness: A new look at no-significant-difference findings. *Journal of Asynchronous Learning Networks*, 4(1), pp.33–39.

Karsenti, T. and Fievez, A., 2013. *The iPad in education: uses, benefits, and challenges - a survey of 6057 students and 302 teachers in Quebec, Canada*. [pdf] Montreal: Center for Interuniversity Research on Training and the Teaching Profession (CRIFPE). Available at www.karsenti.ca/pdf/iPad_report_Karsenti_Fievev-EN.pdf [Accessed 3 August 2016].

Kennewell, S., 2001. Using affordances and constraints to evaluate the use of information and communications technology in teaching and learning. *Journal of Information Technology for Teacher Education*, 10(1-2), pp.101-116.

Khoo, E., Merry, R., Nguyen, N.H., Bennett, T. and MacMillan, N., 2013. Early childhood education teachers' iPad-supported practices in young children's learning and exploration. *Computers in New Zealand Schools: Learning, Teaching and Technology*, 25(1-3), pp.3-20.

Koehler, M.J., Mishra, P., and Cain, W., 2013. What is Technological Pedagogical Content Knowledge (TPACK)? *The Journal of Education*, [e-journal] 193(3). Available through: University of the Witwatersrand Library website: https://0-www-jstor-org.innopac.wits.ac.za/stable/24636917 [Accessed 26 October 2018].

Krauskopf, K., Zahn, C. and Hesse, F.W., 2012. Leveraging the affordances of Youtube: The role of pedagogical knowledge and mental models of technology functions for lesson planning with technology. *Computers and Education*, 58(4), pp.1194-1206.

Lane, J., 2012. TPACK iPad project in schools (TIPS) Phase 1. In: ACEC2012: Its Time Conference (Australian Computers in Education Conference), Australian Computers in Education Conference 2012. Perth, 2-5 October 2012.

Lange, T. and Meaney, T., 2013. iPads and mathematical play: A new kind of sandpit for young children. In: *Proceedings of the Eighth Congress of European Research in Mathematics Education (CERME 8).* Antalya, Turkey, 6-10 February 2013. Ankara: Middle East Technical University.

Laurillard, D., Stratfold, M., Luckin, R., Plowman, L. and Taylor, J., 2000. Affordances for learning in a non-linear narrative medium. *Journal of Interactive Media in Education*, 2000(2), pp.1-19.

Maher, D., 2013. Pre-service primary teachers' use of iPads to support teaching: Implications for teacher education. *Educational Research for Social Change,* 2(3), pp.48-63.

McFarlane, C., 2013. iPads and their potential to revolutionize learning. In: J. Herrington, A. Couros, V. Irvine [eds], *Proceedings of EdMedia + Innovate Learning 2013.* Victoria, Canada, 24-27 June 2013. Waynesville: Association for the Advancement of Computing in Education..

McGrenere, J. and Ho, W., 2000. Affordances: Clarifying and evolving a concept. *Graphics Interface, 2000(May), pp.179-186.*

Meyer, B.,2013. iPads in inclusive classrooms: ecologies of learning. In: Sampson, D. G., Spector, J. M., Ifenthaler, D. and Isaias, P., *Proceedings of the International Association for Development of the Information Society (IADIS) International Conference on Cognition and Exploratory Learning in the Digital Age* (CELDA). Fort Worth, United States of America, 22-24 October 2013). Lisbon: International Association for Development of the Information Society.

Mishra, P. and Koehler, M.J., 2006. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), pp.1017-1054.

Murray, O.T. and Olcese, N.R., 2011. Teaching and learning with iPads, ready or not? *TechTrends*, 55(6), pp.42–48.

National Association of Advisors for Computers in Education, 2012. *The iPad as a tool for education: a study of the introduction of iPads at Longfield Academy, Kent.* [pdf] Nottingham: NAACE. Available at: https://learningfoundation.org.uk/wp-content/uploads/2015/12/Longfield-The_iPad_as_a_Tool_for_Education.pdf [Accessed 3 August 2016].

New Media Consortium, 2016. *NMC Horizon report: 2016 higher education edition.* Austin: New Media Consortium.

Nguyen, L., Barton, S.M. and Nguyen, L.T., 2014. iPads in higher education—hype and hope. *British Journal of Educational Technology*, 46(1), pp.190–203.

Norman, D., 1999. Affordance, Convention and Design. *Interactions*. 6(3), pp.38-42.

Oakley, G., Pegrum, M., Faulkner, R. and Striepe, M., 2012. *Exploring the pedagogical applications of mobile technologies for teaching literacy*. [pdf] Crawley: The University of Western Australia. Available at: http://www.education.uwa.edu.au/data/assets/pdf_file/0003/2195652/AISWA-Report-FINAL-Final-101012-2.pdf [Accessed 3 August 2016].

Oliver, M., 2005. The problem with affordance. *E-Learning and Digital Media*, *2*(4), pp.402–413.

Orlikowski, W., 2007. Sociomaterial practices: Exploring technology at work. *Organization Studies,* 33(2), pp.113-125.

Reid, D. and Ostashewski, N., 2011. iPads in the classroom – new technologies, old issues: are they worth the effort? In: AACE (Association for the Advancement of Computing in Education), *Proceedings of ED-MEDIA 2011-World Conference on Educational Multimedia, Hypermedia & Telecommunications.* Lisbon, Portugal, 27 June – 1 July 2011. Waynesville, NC: Association for the Advancement of Computing in Education.

Puentedura, R.R., 2014. SAMR: A contextualized introduction. *Lecture at Pine Cobble School,* unpublished*.*

Quidwai, S. and Norman, C., 2016, August 9). iPA: Technology + Communication = Empathy and Better Health Care. [online] Los Angeles: Keck School of Medicine, University of Southern California. Available at: http://paeaonline.org/ipa-technology-communication-empathy-and-better-health-care/ [Accessed 24 August 2016].

Reed, A., 2013. iPad's for teaching and learning? "A snapshot of how Iceland is doing it." In: R. McBride and M. Searson (eds), *Proceedings of SITE 2013-Society for Information Technology and Teacher Education International Conference.* New Orleans, United States of America, 25-29 March 2013. Chesapeake: Association for the Advancement of Computing in Education.

Reichert, M.C., 2016. *iPadagogy: An examination of teaching practices in a 1:1 initiative*. DEd. University of Delaware. Available at http://udspace.udel.edu/bitstream/handle/19716/19886/2016_ReichertMichael_DEd.pdf?sequence=1&isAllowed=y [Accessed 30 November 2016].

Rietveld, E. and Kiverstein, J., 2014. A rich landscape of affordances. *Ecological Psychology*, 26(4), pp.325–352.

Sackstein, S.L., 2013. *Teachers' professional dispositions and orientation towards tablet technology: towards a more nuanced understanding of teachers' adoption of technology in South African private secondary schools* MEd. University of the Witwatersrand. Available at: http://wiredspace.wits.ac.za/jspui/bitstream/10539/15875/2/Suzanne%20Sackstein%208601834R%20Research%20Report.pdf [Accessed 23 June 2016].

Seau Yoon, F., Ho, J. and Hedberg, J. G., 2004. Teacher understandings of technology affordances and their impact on the design of engaging learning experiences. *Educational Media International*, 42(4), pp.297–316.

Semmelmann, K., Nordt, M., Sommer, K., Röhnke, R., Mount, L., Prüfer, H., Terwiel, S., Meissner, T.W., Koldewyn, K. and Weigelt, S., 2016. U can touch this: how tablets can be used to study cognitive development. *Frontiers in Psychology,* [e-journal] 7(1021), pp.1-19. https://dx.doi.org/10.3389/fpsyg.2016.01021

Souleles, N., Savva, S., Watters, H., Annesley, A. and Bull, B. ,2015. iPads and art and design students. *British Journal of Educational Technology*, [e-journal] 46(1), pp.131–141. http://dx.doi.org/10.1111/bjet.12132.

Spark, L. and Sackstein, S., 2014. Teaching and Learning with Technology: A Conceptual Analysis. In: M Searson and M Ochoa [eds]. *Proceedings of the Society for Information Technology and Teacher Education International Conference,* Chesapeake: Association for the Advancement of Computing in Education.

State of New South Wales, 2012. *Use of tablet technology in the classroom*. [pdf] Syndey: NSW Department of Education and Communities. Available at http://fad.teluq.ca/teluqDownload.php?file=2013/11/iPad_Evaluation_Sydney_Region_v2.pdf [Accessed 6 August 2016].

Traxler, J., 2010. Students and mobile devices. *Research in Learning Technology* [e-journal] 18(2), pp.149–160. https://doi.org/10.1080/09687769.2010.492847

Trilling, B. and Fadel, C., 2009. *21st century skills: Learning for life in our times*. San Francisco: Jossey-Bass.

Valstad, H. and Rydland, T. (2010). *iPad as a pedagogical device*. MTEd. Norwegian University of Science and Technology. Available at: https://www.iktogskole.no/wp-content/uploads/2011/02/ipadasapedagogicaldevice-110222.pdf [Accessed 25 June 2016].

Warringa Park School, 2013. *Affordances of iPads for special needs learners: an exploration of the contributions and impact of iPads (tablets) on the everyday practices of students and teachers in a special school setting.* Hoppers Crossing: Warringa Park School. Available at: http://www.waringapark.vic.edu.au/wp-content/uploads/2014/07/iPad-Research.pdf [Accessed 25 June 2016].

Zielezinski, M.B. 2016. What a decade of education research tells us about technology in the hands of underserved students. *The Education Digest*, 82(3), pp.30-34.