Teachers' experiences of technology-based teaching and learning in the Foundation Phase

D. M. Hannaway [a,*] and M. G. Steyn[b]

[a]Department of Early Childhood Education, University of South Africa, Pretoria, South Africa;
[b]Department of Early Childhood Education, University of Pretoria, Pretoria, South Africa

*Correspondence to: D.M. Hannaway, Early Childhood Development Education, AJH van der Walt building 7-57, University of South Africa Main Campus, Preller St, Muckleneuk Ridge 0003, Pretoria, South Africahannad@unisa.ac.za

ABSTRACT

This paper presents one aspect of a larger scale doctoral study, namely the teachers' experiences of technology-based teaching and learning in the Foundation Phase. Technology is a huge driver of change and South African education has to change regularly to meet the requirements set out by the Department of Education, including the development of learning outcomes for the 21st century. This study therefore explored teachers' experiences of technology-based teaching and learning in the Foundation Phase. Qualitative case study research methods such as photo voice, semi-structured interviews and field notes were conducted within two cases of technology-rich schools and examined through the Technological Pedagogical and Content Knowledge framework. Data yielded results that correlated with the theoretical framework namely: technological knowledge; pedagogical knowledge; and content knowledge, as well elements such as technological tools, 21st century skills and technology-based teaching and learning in the Foundation Phase. Finally, the significance of this study was that the data gathered proved worthwhile in producing a framework in order to understand Foundation Phase teachers in context as well as provide a robust contribution to the way in which technology-based teaching and learning occurs.

Introduction

Education in South Africa is altering invariably according to the stipulations by the Department of Education, such as the development of learning outcomes for the twenty-first century which recognize learners to use information in particular contexts (Department of Education [DOE], 2001; Law & Chow, 2008b in Leendertz, Blignaut, Nieuwoudt, Els, & Ellis, 2013, p. 1). According to Maaga (2009, p. 1), the early childhood phase of birth to nine years of age is the most crucial phase for every person. In South Africa, the Foundation Phase caters for children from 5 to 9 years (Grades R-3 of schooling) (Department of Education, 2001). For the purpose of this study the older children of this cohort (9 years) will be referred to as Foundation Phase learners in Grade 3. The Foundation Phase of formal education incorporates these years and ensures that quality early learning provides children with the best possible start in life. A firm learning foundation in the Foundation Phase presupposes attention to, as well as understanding, how to teach these digitally inclined learners.

1

Furthermore, Weiler (2004, p. 46) suggested that, 'it may be that academe, and indeed the entire world, is currently in the middle of a massive and wide-ranging shift in the way knowledge is disseminated and learned'. The role of technology in learning has great importance today as the world is being transformed by digital technologies at an expeditious rate (Mishra, Koehler, & Henriksen, 2011, p. 23). Devereux (1933, p. 1) posits:

> Today the world of the learner is almost unbounded. He [*sic*] must acquire facts relating to a bewildering variety of places and things; he must acquire appreciation of far-reaching interrelationships. The curriculum and methods of teaching must undergo a continuous appraisal. New subject matter and new devices for instruction are being scrutinized for their potential contributions to the learning process.

All through history, technology generates the promise of a revolutionary society, and a revolutionary change in education by virtue of technological advances. The future promises more of the same technological progression according to Mishra et al. (2011, p. 23). This study explored the use of technology-based teaching and learning (TbTL) in the Foundation Phase through teachers' experiences thereof, specifically the aspects that influenced the Foundation Phase teacher's teaching. What recommendations can be made to ensure TbTL in the Foundation Phase is successful?

Technological Pedagogical and Content Knowledge

Shulman (1986) bore the idea of *Pedagogical Content Knowledge* (PCK). Using PCK as a point of departure, Koehler and Mishra (2005) highlight the importance of *Technological Pedagogical and Content Knowledge* (TPACK) for understanding effective teaching with technology. Moreover, this framework considers teacher knowledge regarding technology as significant, yet not isolated nor unrelated from the contexts of their teaching. Koehler and Mishra (2009, p. 60) state that the interaction of three bodies of knowledge, namely content, pedagogy and technology, comprises the TPACK framework. TPACK in this study will refer to the theoretical framework since it represents technology integration in the Foundation Phase.

Niess (2005, p. 510) states that

> TPACK, however, is the integration of the development of knowledge of subject matter with the development of technology and of knowledge of teaching and learning. And it is this integration of the different domains that supports teachers in teaching their subject matter with technology.

In this vein, the TPACK framework was a useful organizational structure for defining what it is that teachers need to know to integrate technology effectively (Archambault & Crippen, 2009). TPACK in essence consists of seven knowledge areas as outlined below and at the centre of the framework is the interaction of all three bodies of knowledge known as TPACK (see Figure 1).

(1) Technological knowledge (TK) refers to an understanding of the various technologies that exist (Schmidt et al., 2009, p. 125) TK includes standard technologies and more advanced technologies as well as the way in which to use the technological tools and resources (Koehler & Mishra, 2009; Mishra et al., 2011).
(2) Content knowledge (CK) may be defined as the knowledge of the subject matter according to Mishra et al. (2011, p. 23). Shulman (1986) elaborates further to state that CK includes knowledge of theories and concepts, conceptual frameworks as well as knowledge relating to acquired ways of establishing knowledge.
(3) Pedagogical knowledge (PK) encompasses knowledge about the practices and processes of teaching and learning and includes, amongst others, lesson planning, classroom management and assessment methods (Koehler & Mishra, 2009; Mishra et al., 2011).
(4) PCK is knowledge about how to adequately integrate pedagogy and content to better teaching practice in a specific content area (Schmidt et al., 2009; Shulman, 1986). PCK embodies
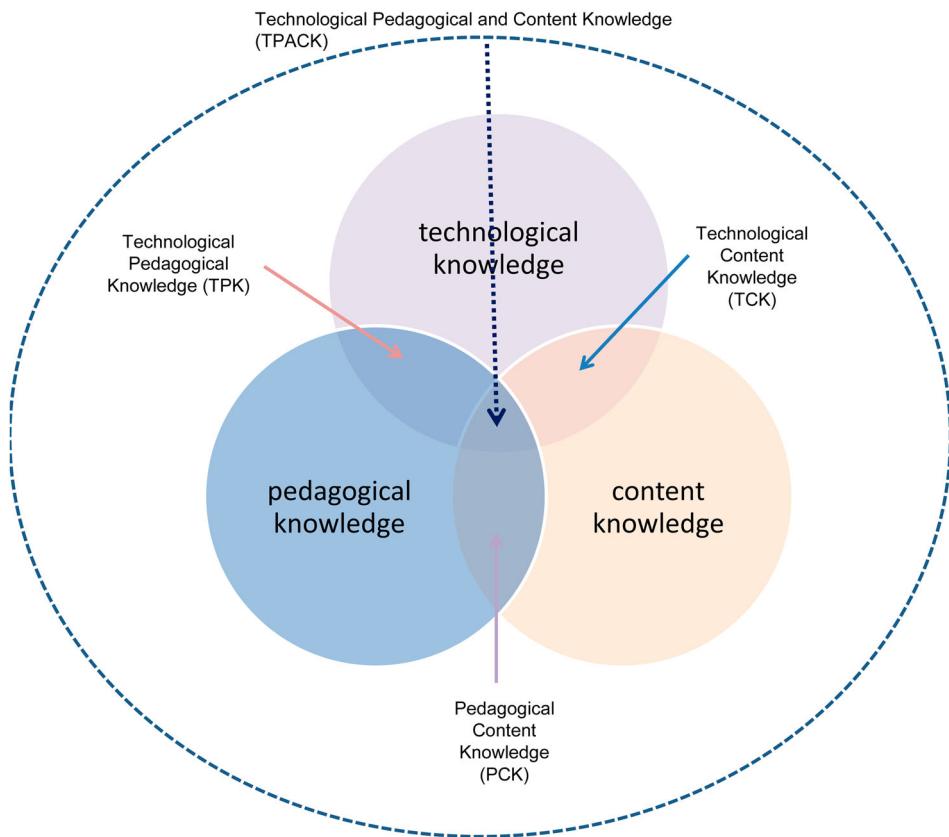
Figure 1. Conceptualization of TPACK framework (Reproduced by permission of the publisher, © 2012 by tpack.org).

knowledge of common misconceptions and likely preconceptions students bring with them to the classroom according to Archambault and Crippen (2009).

(5) Technological content knowledge (TCK) refers technology usage that can alter the way that learners practice concepts in a certain content area (Schmidt et al., 2009). Koehler and Mishra (2009, p. 65) postulate that 'understanding the impact of technology on the practices and knowledge of a given discipline is critical to developing appropriate technological tools for educational purposes'.

(6) Technological pedagogical knowledge (TPK) refers to the affordances and constraints of technology as an enabler of different teaching approaches (Mishra & Koehler, 2006). Leendertz et al. (2013) suggest that technology should be connected to pedagogy to add value to teaching and learning and therefore cannot be regarded as context-free.

(7) TPACK refers to the knowledge and understanding of the interplay between CK, PK and TK when using technology for teaching and learning (Schmidt et al., 2009). It includes an understanding of the complexity of relationships between students, teachers, content, practices and technologies (Archambault & Crippen, 2009).

Literature review

Twenty-first[t]-century skills

According to Kruger (2014), technology, specifically electronic technology, is transforming the way that people work, live and play. Bearing this in mind, the following section reviews literature regarding the skills of the twenty-firstcentury, and then proceeds to discern the term, with all the elements of digital literacy.

Firstly, during 2009, the Assessment and Teaching of Twenty-first Century Skills project (ATC21S), a multi-year, multinational, public–private partnership project, developed a series of white papers to conceptualize changes and define the parameters of twenty-first-century education (Griffin, Care, & McGaw, 2012, p. 6). The specific skill needs from the above-mentioned project were classified into the following categories according to Griffin et al. (2012):

- Ways of thinking incorporated problem-solving, critical thinking, creativity and innovation, meta-cognition development as well as learning to learn.
- Ways of working embodied collaboration, teamwork and communication.
- Tools for working constituted information and ICT literacy.
- Living in the world included elements of social and personal responsibility, components of life and career development, as well as a shifting priority on local and global citizenship.

Secondly, according to the National Research Council (NRC) (2008) in America, twenty-first-century skills were first classified under five skills, namely adaptability, complex communication skills, non-routine problem-solving skills, self-management/self-development and systems thinking. The above-mentioned five skills were subsided into three broad collections, namely cognitive skills, inter-personal skills and intrapersonal skills (NRCouncil, 2011).

Siraj-Blatchford and Siraj-Blatchford (2006) recognize four key areas of TbTL to support twenty-first-century skills, specifically in Early Childood Education. These skill areas are briefly outlined below:

(1) *Communication and collaboration*
    By nature, young children problem solve collaboratively, as well as construct, draw or record, use screen-based applications and experiment effortlessly with technology.
(2) *Creativity*
    Creativity is supported when children are endorsed to look at novel ideas playfully, to know that a choice is always available, to make connections between ideas, to compare these ideas and to account for an array of opinions (Edwards & Hiller, 1993). Technology, such as a competent application, supports children in being creative.
(3) *Socio-dramatic play*
    Innovations and improvizations of both existing hardware and software use child's play to reproduce shop environments, family situations and so forth.
(4) *Learning to learn*
    Papert (1980) indicates that technology helps young children to think about thinking. Moreover, Kalaš (2010, p. 29) posits that technology that establishes metacognition is the same as that which is beneficial to communication, collaboration, creativity and socio-dramatic play in children.

Recent research reviewed (Griffin et al., 2012; NRC, 2008, 2011; Siraj-Blatchford & Siraj-Blatchford, 2006) highlights that although different names are given to a set of skills that are necessary in the twenty-first century, the underlying elements are mostly uniform. Skills such as communication, creativity, collaboration, critical thinking, problem-solving and self-development underpin the competences that are required to function effectively in schools in this day and age.

Digital literacy

At the core of twenty-first-century skills, lies the term digital literacy. Belshaw (2012, p. 18) is of the opinion that 'problems around digital literacies are not dry, academic problems but real-world, everyday issues affecting individuals, organisations and communities worldwide'. According to the National Council for Curriculum and Assessment (NCCA) (2004), three reasons are often referred to for advocating the use of technology in education which provides learning opportunities in line with the development of twenty-first-century skills. Firstly, students' motivation and achievement

increments are often the product of using technology in teaching and learning. Secondly, recognition is made to the permeation of technology in our daily lives and the society in which we live. Lastly, as a result of the above-mentioned, it is contended that the levels of low digital literacy should be addressed so as to allow individuals to be functional in the knowledge society. In this study, the term digital literacy, therefore, refers to the capabilities that an individual possesses in order to teach and/or learn in a digital age. It is, therefore, important to understand digital literacy in order to enhance the level thereof when using TbTL.

Twenty-first-century teaching

With the prevalent development in the use of digital technologies for learning, government, educators and subject disciplines are in a quandary. Belshaw (2012, p. 19) therefore asks the following questions: What are the new skills called that are professedly necessary to function optimally in society today? How can these new skills be taught? Who is in the best position to transfer these skills?

Noss (2012, p. 4) posits that commanding features of the workplace should not be the only factor that controls policy or practice. It is agreed that technology does influence existing culture, as well as the culture being influenced by it. Therefore, it is crucial that one is cognizant of the above-mentioned in order to know how to respond to technology. For example, technology has mostly pertained to institutions until now, but one has arrived at a stage where technology has shifted from the institution to the home, the pocket and the street – technology has become personal (Noss, 2012, p. 4). It, therefore, leads to the question of how do children in the twenty-firstcentury learn? And furthermore, how should twenty-first-century children be taught?

Laurillard (2008, p. 12) postulates that the range of teaching methods were consequentially established from the prerequisites of education and also from the means at disposal. Teaching methods have evolved from small group to large group practices, from cave walls to paper and from enlightenment to the classroom. Yet the teaching and learning theories that have accompanied education over the centuries are largely concerned with 'tell-practice-test' (Laurillard, 2008, p. 12). It appears that the manner in which theories on education are formed does not align with the development of technologies.

For instance, education theories on what it takes to learn effectively have evolved strongly since the nineteenth century. Dewey's 'experiential learning' was the emphasis of theory relating to learning (Dewey, 1938). Thereafter, during the twentieth century numerous captions were given to educational theories, such as constructivism, social constructivism; inquiry-based education; metacognition; situated learning; reflection and collaborative learning (Entwistle, 1991; Harel & Papert, 1991; Jonassen, 1994; Lave & Wenger, 1991; Papert & Harel, 1991; Vygotsky, 1962) which all bestowed learning as a verb – an active process. During the middle of the twentieth century, the computer surfaced and subsequently, a variety of digital technology. Thus, there appears to be distinguishing features of educational learning theories in accordance with the various types of experiences that technology offers, such as inquiry, discovery, problem-solving and collaboration.

It is easily understood from the above-mentioned that due to the rapid advance in technology, practical teaching and learning implications also need to be investigated. 'It is about changes to the curriculum, teaching styles, organisation and support systems within schools' (Barton & Armstrong, 2003). Laurillard (2008) claims that technology is most beneficial when it has to meet a challenge instead of being employed as a solution to a problem. The importance of the above-mentioned is to emphasize that teaching practice and the implications that technology has for learning should be viewed from the stance of meeting aspiring educational aims and not vice versa (Department for Education and Skills, 2005).

It is thus necessary to consider the teaching approach, as well as the type of technology that is most beneficial to young learners.

> To participate and take advantage, citizens must be digitally literate – equipped with the skills to benefit from and participate in the Information Society. This includes both the ability to use new ICT tools and the media literacy

skills to handle the flood of images, text and audio-visual content that constantly pour across the global networks. (Europe's Information Society Thematic Portal, 2007)

Laurillard (2008, p. 14) highlights further that the responsibility and function of the teacher is not necessarily synonymous with that of the learner:

> The teacher has the opportunity to learn about their learners' points of view and their practice, but the teacher's knowledge is privileged over that of the learner. As a consequence, it is their job to ensure an intelligible learning experience - they must adapt the practice environment to the capabilities of their learners, provide the appropriate goals and feedback, and reflect and learn from that process, as much as the learners learn.

Research methodology

Research design

I chose to make use of case study research for the purpose of acquiring a deeper understanding of the experiences and descriptions of TbTL in the Foundation Phase. Within the interpretivist paradigm, this case study endeavoured toward a multifaceted understanding of participants' relations and interactions in teaching situations in order to make sense of TbTL. This case study concentrated on one instance which was the unit of analysis, namely TbTL and was bound in the Foundation Phase at two different research sites. The primary research sites were two chosen schools in Gauteng due to the fact that the environment was identified as data rich, which implies that the schools are technologically inclined.

Ethical considerations

Ethical regulations from the institution under study were strictly adhered to and informed consent was attained from the participants. In their consent, participants were guaranteed safety, voluntary participation and the option to withdraw from the study at any time. The participants in the study were safeguarded from harm as they were not exposed to any acts of deception or betrayal in the research process or outcomes.

Data collection techniques

With reference to qualitative research, Creswell (2012, p. 212) posits that the researcher collects multiple types of information in order to answer the question and establish the complexity of the central

Table 1. Projection of data collection.

Projection of data collection

Phase	Data collection strategy		Objective
Phase1	Administration	1. Ethical clearance	• Permission to conduct research
		2. Contact participants	• Establish relationship with schools
	3. Correspondence with participants and parents		• Explain nature and intent of study
Phase 2 Facilitate Photo Voice	1. *Photo Voice technique* • Discussions • Preliminary field notes		1. Orientation *4. Field notes* 2. Exhibition
Phase 3	2. *Interviews (teachers)* Analysis		3. Wrap-up • Gather data • Interpret data

Table 2. Photo voice sessions.

Session	Participant's role	Researcher's role

1. Orientation	Given prompt for taking the pictures: *How do you teach?*
	    Given 3 days to take photographs
		Purposively selected participants
		    Films developed and photograph's printed

2. Exhibition	Displayed pictures individually in a classroom
	    Chose picture(s) that was most representative of their experience of TbTL
		Facilitated discussion
		    Took field notes

3. Wrap-up	Answered semi-structured interview questions	Used pictures as a starting point for interview
		    Facilitated, recorded and transcribed interview
		    Pictures and field notes were analysed and interpreted

phenomenon. In order to add to the ability of interpreting the data, I used the photo voice technique, interviews and field notes to probe deeper into understanding the Foundation Phase teachers' experience of TbTL. Data collection consisted of three phases which are outlined in Table 1.

Photo voice method

In order to implement this method, I made use of a step-by-step guide to facilitating a photo voice project, as compiled by Olivier, Wood, and De Lange (2009). The photo voice method involved cameras being issued to participants who are prompted to take pictures of people or things that are closely connected to the research topic. The study consisted of three sessions (Orientation, Exhibition and Wrap-up) outlined in Table 2.

Sample

Participants' names were not disclosed so as to protect their anonymity and confidentiality. The photographs and field notes offered data that were both interesting and of great value in eliciting responses to teachers' experiences of TbTL in the Foundation Phase. Finally, significant points that were extracted from the interviews were also discoursed.

Results

Case 1

The technological environment of case 1 has mobile Apple Laptops that learners are able to use throughout the wireless campus for research-relevant topics of discussion. Observation of the Foundation Phase school premises showed that there is a computer room (lab) for the children which has been in place for a number of years, as well as a teacher's workroom and an iPad lab per grade for the use in class. The interview with the teacher also conveyed that an iPad initiative was started by the former principal of the school who then gained financial and legal permission from the executives to implement the use of this technological tool. Upon observation of the physical environment, it is evident that technology is tool that is used for learning.

Participant 1

Participant 1 is a 44-year-old female teacher with 21 years of local and international teaching experience. She holds qualifications of a 4-year Junior and Pre-primary diploma as well as a 2-year Further Diploma in remedial education (Photograph 1).

Participant 1 took a number of photographs of her learners engaging in technology-based learning as a result of her technology-based teaching. I specifically titled the selection of photographs 'twenty-first-century skills' as it clearly shows signs of communication, collaboration and creativity amongst other skills. This participant makes mentions of creativity in terms of her teaching:

> I'm a very creative teacher and creativity has always been my drive in my teaching.

Photograph 1. Participant 1's experiences of TbTL in the Foundation Phase titled 'twenty-first century skills'.

As it is evident in the numerous photographs, this participant makes use of technology wherever possible to benefit teaching and learning and developing twenty-first-century learners. She is willing to implement whatever she is challenged with, as she states:

> Whatever technology brings us … Of course as long as it (technology) can be integrated I think it is to the children's benefit. Because we cannot, one cannot stay behind because the children are learning at an early age they're learning things that we don't learn, and we are mature. So we've got to keep abreast and I think if there's something new out there, yes I want it, I want to try it and I want to find out what's out there.

Questions in the interview schedule were broadly categorized around enquiry into this participant's technological, content and pedagogical knowledge which were derived from the TPACK framework. Further categories of questions included the technological environment, the content that was taught and the tools used for teaching. Data analysis of the interview with reference to the discussions held during photo voice and relevant field notes follows.

With regard to using technology in the Foundation Phase, Participant 1 believes that *it has its place* but that *there should be a balance* in terms of teaching approaches. She further comments that *technology for me, enhances your teaching, you do not base your teaching on it*.

Participant 1 tries to integrate technology through various teaching approaches in order to meet the needs of the learners she teaches:

> (I) find ways of teaching it in a different way, because children learn different ways and if you adjust your methods of teaching, hopefully you can reach more children … children can't always identify the way they learn, the teacher's there to help them to identify how it happens.

Moreover, this participant believes that the successful integration of technology for teaching and learning is largely dependent on the teacher, as stated:

> I think it really depends on the teacher how you integrate it. It's more your creativity and your goal, as I said of your lessons, of what you, do you wish to attain at the end of the lesson.

The benefit of technology, when used appropriately, exceeds the limitations thereof by *capturing children's interests quickly and acquiring twenty-first-century skills.* Another advantage of using technology for teaching in the Foundation Phase is that it serves as a motivating factor, as Participant 1 states:

… children, your weaker children specifically, it is a very high way of motivating the children and giving them, boosting their self-esteem, because suddenly they find that if they might not be able to do the sum in the book, with a good old fashioned piece of paper and pencil, they might feel they achieve it on an iPad. So you boost those children's self-esteem, who really might not be able to achieve in the academic, in the normal academic work that is required of them.

With regard to skills, Participant 1 feels that communication and collaboration, an important twenty-first-century skill, is enhanced through the use of technology. Since she works with young children, parental involvement is fundamentally important and the use of technology to communicate with parents is beneficial:

Well, we communicate with the parents through the D6 Communicator, which you can download on your iPad, iphone, Android, whatever device you have. So your communication is 24/7 – your newsletters, your sport fixtures, everything is via that specific D6 Communicator …

The environment of this school lends itself to using technological tools without unusual glitches, but Participant 1 feels that although this is the case, the content still has to be selected carefully. She feels that *it's really troubleshooting and a lots of hours of research* that is necessary on the part of the teacher in order to access appropriate teaching and learning (digital) material. Her approach to selecting digital content is mentioned below:

So for me it depends on what is available and how applicable it is … the content must be on the children's level, although I try it and I play with it first. It must be user friendly. If you don't use it you don't know what's going on.

On the other hand, a disadvantage, although limited to this participant's technological environment, is that having one-to-one devices is far more valuable to teaching and learning than shared technological tools. Participant 1 mentions that if there were anything she could adapt in the environment, it would be that each child has their own device to work with.

I would love that each child has an iPad. Some of my projects I work for weeks on end. So that's the challenge if you don't have an iPad per child on a consistent basis.

From a personal standpoint, this participant feels that South Africa is lagging behind when it comes to knowledge and skills needed in order to implement technology for teaching and learning:

… there's some good ideas locally as well, but they are far ahead with IPad integration. We are very far behind.

Finally, the only major limitation of technology as described by this participant is that children's physical conditions can deteriorate due to a more sedentary lifestyle caused by the overuse of technology. She mentions:

due to the fact that it provides instant gratification e.g. games, they (children) often expect that in the normal school environment and we have to teach them to persevere without necessarily receiving a reward.

Case 2

Field notes from discussions with the teacher provide information that the school offers all-round education to over 800 girls from Gr 0 to matric. The technological environment at the school has progressed to now include interactive whiteboards and a computer in every classroom as well as the use of an iPad per learner in the older grades which is in the process of being implemented in the Foundation Phase. It is apparent from discussions with the participants that technological content includes email etiquette and internet safety while one of the pedagogical approaches is that of the 'flipped classroom' whereby videos are posted before lessons so homework is done before and not after teaching.

Participant 2

Participant 2 is a 38-year-old female teacher with a 4-year Higher Diploma in Education qualification and 16 years of teaching experience (Photograph 2).

Photograph 2. Participant 2's experiences of TbTL in the Foundation Phase titled 'technological tools'.

The photographs that Participant 2 captured depicted a number of different tools that are used in technology-based teaching such as the interactive whiteboard and the desktop computer in her classroom. Hence, the choice of the photograph's title is 'technological tools'. It was evident that technological tools used are of importance to this participant as she makes mention of numerous tools that are used in the technological environment of case 1, namely: Smartboards, computers, iPads and iPad Minis and Smart document camera as well as the mention of various software. Similarly to the teacher participant in Case 1, this participant agrees that you have to be creative in the use of technology to enhance teaching and learning:

> You just need to take a chance and use it and try.

As with Case 1, Case 2 only included one teacher and therefore the data generated from the semi-structured interview with this participant as well as data from the discussions of her chosen photograph and field notes are discussed in detail below. The interview schedule was the same as the teacher participant in Case 1.

Technology is integral to teaching for Participant 1 and is *needed daily. All our assessments, our reports … everything is technological*. Furthermore, the school environment is very supportive of using technology for teaching and learning and tries to keep up-to-date with trends and development in technological tools and approaches to teaching, as well as developing the staff accordingly. Participant 2 mentions:

> the school was already using computers, but that was girls going down to a computer lesson as such and then it's just been built on from there. (We) have all the content that the students need and if you don't – you have it available.
> this year we've had a staff development, just focusing on the 21st Century skills, critical thinking skills and we've been tasked to implement that in our teaching.
> … Smart Board, software and they run workshops on what's new, how we can use the software integrated into our lessons.

She describes technology as *anything that has been created to make improvements in our daily lives* and she comments on using technology for teaching:

> I think it just enhances your lesson. You can use so much in your lesson, I often tell the girls that I don't know everything, but because we have the Internet, any question that I can't answer, we can go onto the Internet,

10

we can find out, and that also teaches them something like research skills – how to find information. So just to enhance my lesson, make them more interesting, more fun.

As depicted in her chosen photographs, this participant makes use of a number of technological tools, such as *smartboards*, *laptops*, *computers*, *iPads*, *cameras* as well as other software. The specific technology that Participant 2 choses endeavours to put *teaching and learning on par with the international world*, in her teaching approaches so as to make improvements in the way in which she teaches:

We've got our iPads, mini iPads, so if we need to learn outside wherever, if we go on a field trip and we need to take photographs or if they need to answer questions, things like that, they can record it, it's portable.

She also mentions that the technology spills over from the classroom and teaching and learning to enhance sport and homework by means of *various computerized programs* that the learners can work on at home. Similarly communication between home and school is simplified by using technology:

Okay, well, communication is the biggest thing. We use, the use of email, the use of SMS system to communicate with parents … .um. When we need to set up interviews we can just email, if I need to send a message, or if a parent needs to send a message to me urgently, they send an email.

Participant 2 cites many advantages of using technology in her approach to teaching, such as content being readily available while the disadvantages thereof is that it can be tedious to search for the appropriate material and technological glitches still have to be considered:

… you can also waste time going through everything and all that pops up when you're trying to find something. Also when your internet doesn't work, or your wireless doesn't work and you've planned your lesson around using that technology, then you're either stuck or you go back to basics.

This participant believes that the weakness of using technology for teaching is that it often *takes time to learn how to use technology and sometimes there is no electricity to make electrical objects work. Yet*, she makes use of technology on a daily basis whether at home or at work as she believes it *enhances or improves what you can already do … saving time and energy*. In conclusion, Participant 2 advocates the use of technology for teaching as she remarks:

Technology makes it (teaching) so much easier. Technology has definitely refreshed what I do, I still have so much fun, I still have a passion for what I do because things change all the time and new things are exciting.

Discussion

At the heart of the TPACK (see Figure 1) is TbTL which is the interaction of technological, pedagogical and content knowledge. This 'area' where knowledges engage enables teachers, and as a result, learners, to teach and learn content that is appropriate in the Foundation Phase using befitting pedagogy and technology. Additionally, literature and the responses from teacher participants attested to technology-based teaching having a positive effect on the content, pedagogy and administration within schools. Teaching and the implications that technology has for learning should be considered to meet desirable educational aims and not the other way around (Barton & Armstrong, 2003; Department for Education and Skills, 2005; Laurillard, 2008). Empirical data confirmed that teaching is complemented by technology, but that technology should not be the essence of teaching. Furthermore, the discussion of twenty-first-century teaching and learning affirmed that technology is constructive when it is required a consequence rather than being used as a determinant of teaching and learning. The idea in essence is that TbTL is most worthwhile when technology is the culmination of quality teaching and learning.

This study refers to the fact that teaching and learning is already and will become increasingly more digital, as well as the notion that technology has positive effects on both. The world is being transformed by digital technologies which make the role of such technologies and the

subsequent content and skills that are taught important in the way in which we teach young children. Technological, pedagogical and content factors from the findings were exposed. As a result, the following recommendations are made with the aim of endorsing successful TbTL in the Foundation Phase.

Provision of technological infrastructure must be made available to all Foundation Phase classrooms

In order for teachers and learners to take advantage of digital tools for teaching and learning, I recommend that Foundation Phase classrooms are equipped with the necessary technological infrastructure. This arrangement must include connections to internet and Wi-Fi, appropriate devices, as well as relevant hardware and software. This study focussed on two schools that were technology-rich for the reason that the infrastructure and the use of technological tools with the necessary support were established. TbTL has the ability to improve and transform teaching and learning but is dependent on a sound infrastructure. The government must provide this infrastructure and ensure that all schools are adequately equipped with the resources to facilitate TbTL.

A policy framework for Foundation Phase TbTL must be developed

I recommend that the Department of Education provides a policy framework which integrates technology into the Foundation Phase curriculum across all subjects. Young children have a specific learning style and therefore a specific child-centric, play-based curriculum is necessary to which technology can provide support. The Action Plan to 2019 (Department of Basic Education, 2015, p. 18) stresses the priority for dependably designed interventions from the government to contend with the digital divide in South Africa by taking charge of technology betterment. An important but not entirely sufficient to the Foundation Phase dispensation was the Green Paper on ICTs (Department of Communication, 2013). However, this policy framework does not service the Foundation Phase and moreover, does not explicate the pedagogical aspect of teaching and subsequent learning with technology.

Pre-service teacher training must include pedagogical knowledge of TbTL

I recommend that Foundation Phase teacher training programmes include appropriate pedagogical approaches so that new teachers know how to confidently use technology for teaching and learning. New teachers appear comfortable with technological tools, but lacked a comprehensive understanding of how to incorporate such tools into teaching. Higher education institutions that train future Foundation Phase teachers must reconsider the way in which they prepare teachers and include technology in their approach.

Teachers' technological skills and pedagogical understanding require in-service training

I recommend that teachers receive in-service training in two keys areas of TbTL, namely digital skills and pedagogical competence. Schools must enable teachers to teach learners who are going to be well-adjusted twenty-firstcentury citizens. The first set of skills, technological skills, must be developed by teaching teachers how to use technological devices. Teacher training should be offered by departments of education (national, provincial, district and regional), schools and even online programme tutorials to meet this demand. The second skill of pedagogical understanding must be advanced by equipping teachers with the aptitude to integrate technology into the curriculum. To this end, suitable teaching approaches for teaching with technology need to be shared in communities of practice, professional learning groups and other platforms, such as discussion forums.

Teachers need professional development training in key twenty-first century skills

I recommend that professional development workshops focussing on pertinent twenty-first-century skills provide training and development to all Foundation Phase teachers. A new set of skills is required from teachers in order to successfully teach learners of the twenty-firstcentury. The competence that an individual possesses in order to teach and/or learn in a digital age should be developed.

Teachers need support in finding appropriate content

I recommend that a toolkit of appropriate South African content for specific technological tools is developed and shared by innovative teachers to meet the demands of TbTL in the Foundation Phase. Foundation Phase teachers and learners are involved in research which ranges from finding out simple information on the internet to looking for suitable content for successful lessons. The teacher participants particularly mentioned that it can be time-consuming to sift through all the content but it is necessary to know what is offered and what is potentially suitable. In order to provide the appropriate support to choose the actual technology as well as the associated content for the technology, role players need to distinguish that using a certain technology can modify the way that learners grasp concepts in that particular content area.

Closing remarks

Teachers experience technology positively on the grounds that they possess necessary skills and exist in circumstances that enable them to be proficient in TbTL. Teaching (and learning) depends on how knowledge is created, accessed and imparted, through what is being taught and learnt in particular relation to technology. Likewise, teaching has the ability to affect change and contribute on a global scale due to technological advancements and inclusions in education. The way forward relies on an education that creates teachers who develop children to be digitally literate, life-long learners with developed twenty-first-century skills.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributors

DM Hannaway is a PhD student and lecturer in the Department of Early Childhood Education, College of Education, University of South Africa. She is the coordinator of the subject Science and Technology Teaching for undergraduate students and is involved in post graduate teaching and learning within the department. Mrs Hannaway's research interest is technology-based teaching and learning in the early years. She is also engaged in an inter-institutional research project which focusses on the implementation of the South African National Curriculum (Birth to Four).

Dr MG Steyn is a senior lecturer in the Department of Early Childhood Education, Faculty of Education, University of Pretoria. She is the coordinator of the subject Life Orientation. Her main task involves supervision of postgraduate students and she focuses on the publication of articles. The research interests of Dr Steyn relate to the experiences of young people. Adolescents' future expectations from the perspective of the various ethnic groups in South Africa have been researched extensively. She is also interested in how black students experience their tertiary studies at former white institutions, as well as in the challenges they face in order to succeed academically. She is currently involved in the African-Asian Dialogue project (AAD) where research is conducted to determine the factors that play a part in the development of the teacher and student teacher's professional identity. She has also recently joined an interfaculty research project on Peace Education, where she focuses on non-violent behaviour.

References

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, *9*(1), 71–88.

Barton, L., & Armstrong, F. (2003). Engaging with disabling policies: Troubles and contests in a local education authority in England. *Research in Education*, *70*, 37–49.

Belshaw, D. A. J. (2012). *What is digital literacy? A pragmatic investigation*. Durham theses. Durham University.

Creswell, J. W. (2012). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (4th ed.). Boston: Pearson Education.

Department of Basic Education. (2015). *Action plan to 2019 towards the realisation of schooling 2030 taking forward South Africa's national development plan 2030*. Pretoria: Department of Education.

Department of Communications. (2013). *National integrated ICT policy green paper*. Government Gazette, 24 January 2014.

Department of Education (DoE). (2001). *Education White Paper 5 on Early Childhood Education: Meeting the challenge of Early Childhood Development in South Africa*. Pretoria: Government Printers.

Department for Education and Skills. (2005). *Harnessing technology: Transforming learning and children's services*. London: DfES.

Devereux, F. L. (1933). *The educational talking picture*. Chicago, IL: The University of Chicago Press.

Dewey, J. (1938). *Experience and education*. New York, NY: Kappa Delta Pi.

Edwards, C., & Hiler, C. (1993). *A teacher's guide to the exhibit: The hundred languages of children, college of human environmental sciences*, Lexington, KY: University of Kentucky.

Entwistle, N. J. (1991). Approaches to learning and perceptions of the learning environment. *Higher Education*, *22*(3), 201–204.

Europe's Information Society Thematic Portal. (2007). *Digital literacy: Skills for the information society*. Retrieved June 30, 2014, from http://ec.europa.eu/information_society/tl/edutra/skills/index_en.htm

Griffin, P., Care, E., & McGaw, B. (2012). The changing role of education and schools. In P. Griffin, B. McGaw, & E. Care (Eds.), *Assessment and teaching of 21st century skills* (pp. 1–16). New York, NY: Springer.

Harel, I., & Papert, S. (1991). *Constructionism: Research reports and essays, 1985–1990*. Norwood, NJ: Ablex.

Jonassen, D. H. (1994). Thinking technology: Toward a constructivist design model. *Educational Technology*, *34*(2), 34–37.

Kalaš, I. (2010). *Recognizing the potential of ICT in early childhood education Analytical survey*. Moscow, Russian Federation: UNESCO Institute for Information Technologies in Education.

Koehler, M., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research*, *32*(2), 131–152.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70.

Kruger, M. (2014). *Global trends for mobile learning: Focus on learning in Higher Education*. 2nd annual technology for teaching and learning forum. Johannesburg, 19–20 March 2014.

Laurillard, D. (2008). *Digital technologies and their role in achieving our ambitions for education:* Inaugural lecture (pp. 1–40). London: Institute of Education, University of London.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Leendertz, V., Blignaut, A. S., Nieuwoudt, H. D., Els, C. J., & Ellis, S. M. (2013). Technological pedagogical content knowledge in South African mathematics classrooms: A secondary analysis of SITES 2006 data. *Pythagoras*, *34*(2), 232–240.

Maaga, T. (2009). Opening address. In A. Viviers & J. Mabuchi (Eds.), *Nation building from the start. Early childhood development knowledge building seminar*. November 2008. Pretoria: UNICEF/South African Inter-departmental Committee for ECD.

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

Mishra, P., Koehler, M. J., & Henriksen, D. (2011). The seven trans-disciplinary habits of mind: Extending the TPACK framework towards 21st century learning. *Educational Technology*, *11*(2), 22–28.

National Council for Curriculum and Assessment. (2004). *Curriculum assessment and ICT in the Irish context*. A Discussion Paper. Retrieved July 2, 2014, from http://www.ncca.ie/uploadedfiles/ECPE/Curriculum%20AssessmentandICT.pdf

National Research Council. (2008). *Research on future skills demands: A workshop summary*. M. Hilton. Rapporteur. Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

National Research Council. (2011). *Assessing 21st century skills: Summary of a workshop summary*. J. Anderson Koenig, Rapporteur. Board of Assessment, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, *21*(5), 509–523.

Noss, R. (2012). 21st century learning for 21st century skills: What does it mean, and how do we do it? In A. Ravenscroft, S. Lindstaedt, C. D. Kloos & D. Hernández-Leo (Eds.), *21st century learning for 21st Century Skills* (pp. 3–8). Saarbrücken, Germany, September 18–21, 2012. Heidelberg: Springer.

Olivier, T., Wood, L., & De Lange, N. (2009). *Picturing hope: In the face of poverty as seen through the eyes of teachers*. Cape Town: Juta.

Papert, S. (1980). *Mindstorms: Children, computers and powerful ideas*. New York: Basic Books.

Papert, S., & Harel, I. (1991). Situating constructionism. In I. Harel & S. Papert (Eds.), *Constructionism: Research reports and essays, 1985–1990* (pp. 1–17). Norwood, NJ: Ablex.

Schmidt, D. A., Baran, E., Thompson, A. E., Mishra, P., Koehler, M. J. & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, *42*(2), 123–149.

Shulman, L. (1986). *Paradigms and research programs in the study of teaching: A contemporary perspective*. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 3–36). New York, NY: MacMillan.

Siraj-Blatchford, I., & Siraj-Blatchford, J. (2006). *A guide to developing the ICT curriculum for early childhood education*. Cambridge: Trebtham Books.

Vygotsky, L. (1962). *Thought and language*. Cambridge, MA: MIT Press.

Weiler, A. (2004). Information-seeking behaviour in generation Y students: Motivation, critical thinking, and learning theory. *The Journal of Academic Librarianship*, *31*(1), 46–53.