Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

EDUCATION, TECHNOLOGY AND HIGHER ORDER THINKING SKILLS

Lucy Edwards
La Trobe University, Bendigo Campus

Abstract

This research is exploring how emerging technologies are impacting teaching pedagogy and whether these technologies are nurturing higher order thinking in secondary schools in Australia. Technology in education has been identified as a 'wicked problem' (P. Mishra & Koehler, 2008) and a conundrum (Arntzen, 2008). It has been described as an unbearable disturbance to education (Marshall, 2002). It is difficult to resist the lure and illusion of technology's potentialities and this is what makes it so seductive (Abrams, 2014). Technology is a ubiquitous problem in education. It is important that educators explore the gap between potential and reality for technology in secondary schools, particularly in English Language Arts classrooms and whether higher order thinking skills are being nurtured with the use of these technologies. Our theoretical understanding of how learning is occurring through technologies is not keeping pace with the introduction of these technologies in our classrooms (Martin, 2007).

Introduction

This research project explored emerging technology use in secondary school classrooms and whether they are nurturing higher order thinking in students. A literature search revealed that much is assumed about teacher's understandings of a sound pedagogical basis for digital resources use in classrooms. The problem of technology use becomes more complex as the literature also revealed that the lack of uptake of the potentialities of technology in education is identified as partially due to the reluctance of teachers to use it. Whether this is because of lack of skill or an unwillingness to change.

Added to this is the idea that students are now millennials who are highly adept in their use of emerging technologies and expect to be able to use them as seamlesslessly in their learning environments as they do in their daily lives. Even further to this notion that there are political and economic pressures to ensure that the technology that has been provided to schools and teachers be used to justify its cost and can produce improved student outcomes.

There is not going to be one resolution to the quandary of emerging technology use in secondary school classrooms. Secondary school education itself is fraught with expectations. The English Language Arts domain has traditionally been one that is text and dialogue based. Thinking and learning in this domain, in particular, is founded on the ability or skill of each student developing their ability to be literate, critical thinkers and also ever increasing general knowledge. Learning has become caught up in the idea that it can be engaging if technologies are being used. This does not really address the problem that learning may not just be about engagement, or that technology use is improving student learning because it is engaging. Some researchers have found that technology use is distracting and detracts from the ability of the student to gain sound independent critical thinking skills. To compound the problem of technologies in secondary school education is the expectation that their use will re-engage reluctant learners. However, there is evidence to support the idea that emerging technologies are changing the way we think. If critical thinking has any traction at all in schools and learning, it is here that we should examine what is happening, how it is changing our thinking and whether this change is of benefit to student's ability to think critically, to develop higher order thinking skills.

The impact of technology in education and higher order thinking

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

In essence, the research questions are:

1. How does technology inform the use of higher order thinking in the classroom?
2. What are the theoretical assumptions underpinning the use of technology in classrooms?
3. How do educators articulate the pedagogical basis of the use of technology in classrooms?

What is technology in Education?

In general terms, technology in education can refer to both software and hardware. It can refer to student access to online or Internet-based learning opportunities, or it can be referring to access to hardware such as laptop programs, or access to computers in schools. The OECD (2015) report **Students, Computers and Learning: Making the Connection** found that students who used computers moderately in schools tended to have better learning outcomes than students who used computers rarely (OECD, 2015 p. 3) but these findings are based on data collected through PISA testing and therefore has some limitations for its interpretations and ability to be generalised.

For the purposes of this research, technology in education will be limited to that of secondary schooling, and specifically middle school English Language arts classes. It is an examination of the impact of these emerging technologies on our pedagogical articulation of the changes to teaching and learning that these technologies could have and in particular to the ability of technology to foster higher order thinking, critical thinking or deep learning. It is clear from the literature that a recognition that pedagogical understanding was not developed at the same speed that the laptops, iPads or computers were being handed out in schools to students (Mabel, Olinzock, & Okojie-Boulder, 2006; Peluso, 2012). There is also much debate (Hartley, 2013; Li, 2010) about the uptake by teachers of these emerging technologies and that the use of technology in classrooms is teacher dependent and thus a highly contested issue for education as well as the teaching community itself.

The research has not yet reached the equilibrium that is needed to be able to more critically assess what it is that technology is doing in real terms. The somewhat polarised discussion in the research literature about the potentials, or the pitfalls, of technology seems to be holding us back from critically assessing and understanding the impacts of technologies on learning for students and educators for their teaching. This has led to the development of some intense curiosity and questioning of technology in education.

Definition of the term 'education'

The term 'education' itself is a contested idea that is difficult to define (Selwyn, 2011). If 'education' can be thought of as an on-going process where an individual learner is building upon their previous experiences and then at times changing their behavior as a result, then education and learning have been deemed to occur. Thus the meaning of the terms 'teaching' and 'learning' are even more difficult to define when applied to the use of emerging technologies. The terms can become more complex especially when applied to the diverse learning circumstances of students in classrooms across Australia. The principles that underpin our education system are also used as a basis for technology-driven learning such as on-line learning, virtual learning and on-line learning communities (Halsey, 2011). Those questions that many educators ask themselves such as 'What does it mean to learn?', 'How do we learn?' can impact on how we teach, what we teach and even who we teach. The political agendas present in education cannot be ignored and the use of technology in classrooms opens itself up to intense political debate (Buchanan, 2011; Lee, 2012 and Simpson, 2008).

The Problem

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Emerging technologies are purported to offer many potentialities to our lives and their use in education has come with the expectation that these potentialities will be realized with immense benefits to students and their learning. However, it is clear that learning with emerging technologies in secondary schools is fraught with expectations that are often unrealized, and particularly so if teachers have the expectation that higher order thinking should also be nurtured and developed. What seems to be the reality in classrooms across Australia is that even though technology is being used, it is not providing the expected improved learning outcomes at the same rate that these technologies are being incorporated into the everyday classroom experience. As educators, it is imperative to have a sound understanding of the pedagogical benefits of technology use. It is also important for educators and researchers to have a sound theoretical base to begin from for research to have something to offer teaching and learning practice. The problem is that there is a gap in our knowledge of what is actually happening with technology and learning for students.

Technology in education a 'wicked problem'

Technology is a "wicked" problem (Mishra, and Koehler, 2008), it is ubiquitous (G.-J. Hwang & Tsai, 2011; Xin, 2010) and a conundrum (Arntzen, 2008). It is an unbearable disturbance to education (Marshall, 2002). It has also been called 'seductive' (Abrams, 2014). There is no doubt that educators and education are finding it almost impossible to keep up with the exponential proliferation of technological devices, access and potentialities that emerging technologies can provide. The effective and efficient incorporation of technology in education is a globally significant issue (Cox et al., 2013; Facer, 2010; Sokolov, 2001). This is true not only for curriculum documentation but also at the classroom level. Simultaneously, the implication when using the phrase "21st-century learners" ("What is 21st Century Education?," 2010) is that these learners are different to learners before the 21st century in the way that they learn due to technological advances. However, it can be argued that learning at any age or stage or era has not fundamentally changed. Education has become influenced more about how we learn, neuroscience and brain-based learning (Goodrich, 2014). These understandings are being included in education and aid the development of pedagogical improvement.

Technology as a change agent

For educators, technology becomes more of a ubiquitous problem as education is often seen as one of the crucial change agents in society (*Contributing to educational change: Perspectives on research and practice*, 1988). This factor alone can mean that curriculums and schools can be both viewed as an inhibitor of change as well as an instigator of change. The rapid pace of the changing nature of the emerging technologies our 21st-century society experiences causes as much discussion, research and unsubstantiated assumptions as it does provide outrageous claims about the "potentials" and "possibilities" that emerging technologies offer. This in turns spurs researchers, writers and commentators to make statements that claim that technology has the potential to "transform" education, "revolutionize" our curriculums and "engage" our learners on levels that have previously been unprecedented.

Problems with issues with learning technology research

Bennett and Oliver (2011) identify four groups of issues within the learning technology research – pedagogy, technical, organizational and sociocultural – and that theoretically based research in the field of technology in education is "conspicuously absent" (p. 180). Cochrane (2014) agrees with this and lists the "shortcomings" of research. This list includes – lack of explicit and underlying pedagogical theory; lack of transferable design frameworks; general lack of evaluation of projects; lack of longitudinal studies; lack of importance of pedagogical integration and so on (Cochrane, 2014 p. 67). He also concludes that much of the research has focused on the affordances of devices (p. 67).

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Empirical research does not go far enough. Whetten (1989) concluded that theorizing improves our understanding of the research. He proposed that the 'what' and 'how' provides the framework for interpreting patterns or discrepancies for our empirical observations. Empirically based discussions provide the beginning of a research journey, yet without the theoretical direction these discussions tend to "degenerate into heated methodical debates over how fast we are traveling in our research" (Whetten, 1989 p. 491). Roblyer (2005) supports this view by observing that the field of educational technology is complex and that this means that we need a more "organized and persuasive body of evidence on technology's benefits to classroom practice" (p. 192). He concluded that we must "design and carry out research that will both address past concerns about methods and findings and clarify the directions we should take in the future (p. 192).

Roblyer contended that the weaknesses so far in research in educational technology has caused fragmentation, uncoordinated approaches, use of methods that have lacked rigor or ill-matched to the research questions. The use of theory would aid to provide the "pillars of good educational research" (p. 194) and that there are five of these pillars that need to be fulfilled to enable the research to be useful. These five pillars are: the significance criterion; the rationale criterion; the design criterion; the comprehensive reporting criterion and the cumulative criterion (p.195-197). This common-sense approach is laudable but not always achievable in such a diverse field as educational technology research.

Robey, Raymond and Anderson (2012) state that amongst the research of computer impact studies in the fields of computer-human interaction (CHI) much of the focus has been on information technology as an artefact and that these do not engage adequately with the functions and capabilities that technology features make available to potential contexts of use. They posit that "researchers must apply or develop theoretical frameworks that correspond to the phenomena being studied" and that "without clear theoretical conceptualisations of information technology artefacts, impact studies can advance only so far". Derry (2007) provides further insight and proposed that to realize the potential for technology to enhance learning, research must be based on a "secure foundation of robust understanding of learning, teaching and knowledge" (Derry, 2007, p. 503).

Schools and education are lagging behind technology

With the rapidly increasing pace of the introduction of emerging technologies in society, education has been seen to be lagging behind, bound to 19th-century teaching practices (Saavedra & Opfer, 2012). There are arguments that contend educational institutions are in a transitional time and that with the incredible rate at which technology is advancing and entering the classroom, and with the amount of information available at our students' fingertips, educators need to change how they teach to best prepare students for the future (Hertz, 2012). There are some writers that claim that unless education uses these technologies, education as we know it will become obsolete (Gates, 2005; Scott-Webber, 2012).

Lack of Efficient and Effective use of Technology in Schools

Thomson (2010) asserts that technology can make us smarter but the lack of efficient and effective integration of these technologies in schools is what is "holding students back" and "crippling" their learning (A. Thompson, 2010). Vander Ark (2012) contends that learning is the "change lever" and that digital learning will enable all of us to become 'smart'. The contrasting paradigm is that teachers need to not see students wasting time on texting, social media other ubiquitous technology, but to see that these students are learning – just in different ways than we are used to seeing. Christensen (2008) agrees with Vander Ark on this point using as the title of his book **Getting smart: How digital learning is changing the world** (Vander Ark, 2012) to emphasize the significance that technology is indeed a disruption. Christensen believes it is this disruption that will propel us towards real change

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

(2008, p. v.).

Digital Pedagogy

Digital pedagogy has lagged behind the introduction of Web 3.0 tools into schools and educational learning settings. Technological Pedagogical and Content Knowledge (TPACK) (P. K. Mishra, M. J., 2006) is a tool that is being used irregularly across many nations and has become one of the ways that educators can articulate their pedagogical understanding of the why and how technology can be used to enhance learning experiences (Wu, 2013). TPACK is thought to be one way that educators can incorporate technology with more success than previously (Harris, 2011).

24/7 learning capacity

Ben-Jacob (2013) claimed that advances in technology will bring with it the capacity for global learning 24/7, can be multicultural and intercultural and support tolerance and diversity. The learner-centred assumptions of self-motivation and self-engagement imply that students are naturally engaged and that "the modus-operandi of the student today has catapulted distance education into the educational environment" (Ben-Jacob, 2013, p. 2). Friesen (2008) unpacks the claim that we are in a 'knowledge economy' or that users can enjoy the ability to learn at 'anytime, anywhere' with a critique of the ideology that accompanies it. Friesen (2008) highlights the importance of understanding the critical theory behind the claims so that we can 'de-mystify' the implied truth or myth that supplements them.

The ubiquitous notion of emerging technologies and their any-time-any-place any-where catch-phrase has become part of the banalities of everyday life. They are an assumed adjunct to our realities and the distinction between these 'worlds' is not as clear and clean as it has previously been (Friesen, 2008). This has caused some discrepancy within the field of educational technology research. It is difficult to measure this component using theories that are based on the idea that technology is a tool and is isolated from other cultural influences. Friesen concluded that our vocabulary and use of terms can inhibit or extend our understanding of the complex nature of technology in education in particular. He believed that terms such as 'impact' and 'inevitabilities' truncated the discussion and that instead, we should be making use of terms such as 'adaptation', negotiation' and 'interaction'.

New literacies in education

Greenhow (2008) shared this view echoing the idea that what 21st-century learners need from education are for teachers to prepare them to be competent communicators in the emerging on-line marketplace. The push for new literacies should be dynamic and situational specific thus substantiating the concept of individualized, personalized learning that technology offers to these 21st-century learners. It is the rapid pace of change that the emerging technologies are causing that education traditionally cannot keep pace with.

Technology not the solution

Howard Gardner (2000) expressed a word of caution on the introduction of these new technologies being assumed to be "the solution" for the overarching ills of education, teaching and learning that is, or is not occurring in classrooms across the globe. Sokolov (2001) introduced the concept of mass-customized education, based on the advancement of technology that he saw as enabling educators to streamline educational provision. Siegle (2004) argued that literacy itself is changing with the onset of technology, and it is here that the real significance of the need for further research and study into the impact of technology on teaching and learning within education becomes paramount. Fullan and Donnelley (2013) state that our pedagogy has not kept pace with the opportunities that technology has presented to education (Fullan & Donnelly, 2013). His claim is that the 'revolution'

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

needs to have a three-pronged approach, that is pedagogy, change knowledge and technology introduction (2013).

Little improved impact on education outcomes

There is a conception that technology is a mere add-on to the curriculum for some learners and teachers (Selwyn, 2002) and has had little impact on education outcomes overall, despite the political push for increased funding, grants and promises. This is a pessimistic view not shared by those who claim that technological advances will "transform" education (Cochrane, 2014; M. Hopkins, 1997; Postma, 2014). Selwyn posited that the incremental advancement of emerging technologies has the danger of raising initial expectations among the general public and educational community which are often disappointed because they do not deliver the desired beneficial effects. The gap between the rhetoric and reality of technologies should not come as any surprise in educational terms (Selwyn, 2002).

21st-century learners

Conceptually, 21st-century learners are immersed in social media communications, mobile technologies that connect them instantly. Instant messaging, being on-line and connected at all times makes these learners able to use a range of emerging technologies with precision, skill and dexterity. Jackson (2011) supported this view with the idea that 21st-century learners have grown up in an intensive environment of television, movies and video games and that these younger students have developed learning styles where comprehension largely occurs through visual images. It has been claimed by some that technological advances are changing the way we think (Gettler, 2010).

Prensky (2001) has claimed that "digital natives", those born after 1995, are naturally prone to the use of emerging technologies, having been born in the 21st century and have not experienced a time where technologies were not available. Bennett unpacked this claim to some extent and concluded that a key feature of the conception of young people as "digital natives" is the apparently insurmountable gap between them and the less technologically literate older generations (S. Bennett & Maton, 2010). It would not be hard to extrapolate from this that the "digital immigrants", those born before 1995, as outlined by Prensky are incapable of educating these 21st-century learners and preparing them for their futures.

Online learning opportunities

Indeed, this is supported by the view that a new paradigm of education is needed (Aslan, 2013) and that this will include learner-centered, self-directed and possibly both virtual and on-line learning opportunities. Aslan purported that education should change with society. The paradigm shift is being caused by the effect of technology and that this shift is "transforming" our organizations unilaterally. Fullan and Scott (2014) imply that the new paradigm for education is about "new pedagogies" and that is only through the use of these new pedagogies that education can remain relevant for learners.

Deep Learning

Deep learning is based on the social construct of communities of learning or inquiry-based learning. Neither of these educational strategies are new concepts or pedagogies. Weigel (2002) would like to see classrooms transformed into 'knowledge rooms' where students engage in either in a collaborative space which can enrich their "research projects, skill development, seminar discussions, formal debates and creative expression" (2002, p. 16). These knowledge rooms can be either virtual or actual so the use of technology can facilitate the ability for students to collaborate with others globally.

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Critical thinking

Critical thinking has long been seen as one of the key components of education (Friesen, 2008). The question as to whether technology can improve, nurture even, critical thinking skills is what is causing much debate among educators (Gerber & Scott, 2011; A. Thompson, 2010) particularly in the use of gaming as a serious educational tool. The links between learning and technology is a difficult path to navigate and the link between technology and the development of critical thinking skills are even more fraught with assumptions and expectations. It is said that technology can foster creativity (Arnone, Small, Chauncey, & McKenna, 2011) and while the path associated with curiosity, interest, and engagement during learning and research has remained essentially the same, how students tackle research and information-seeking tasks and factors which sustain such efforts have altered dramatically since the pervasive use of the internet as the primary, or sometimes, the only source of information provision.

Critical thinking skills acquisition – not knowledge acquisition

The focus away from knowledge acquisition to the acquisition of critical thinking skills purported by Starkey provided a stimulus for schools to used digital technologies for this primary purpose (Starkey, 2011). However, this "innovative" teaching impetus for education is not really that new to educators. Virtual worlds, social media, Massive Open On-line Courses (MOOCs), simulated learning sites, youtube, indeed anything that is multi-modal is determined to be beneficial for 21st-century learners as the use of 'smart' devices have enabled students to access information at speeds unprecedented before and accessible anywhere anytime. If educators are not employing these technologies then potential learning opportunities are being lost for developing the creativity of these 21st-century learners (P. Mishra, Fahnoe, C., & Henriksen, D., 2013).

Problem-Solving Skills

Technology has also been said to improve problem-solving skills (G.-J. Hwang, Hung, Chun-Ming, Chen, Nian-Shing, 2013) and while these skills are important to learning, it seems questionable that transferable skills and deep learning are occurring. The study that Hwang undertook involved a total of 167 sixth graders, 82 of whom were assigned to the experimental group and learned with the peer assessment-based game development approach, while 85 students were in the control group and learned with the conventional game development approach. The writers of the study found that from the open-ended questions provided informed them that most of the student's perceived peer assessment-based game development as an effective learning strategy that helped them improve their deep learning status in terms of ''in-depth thinking,'' ''creativity,'' and ''motivation.''

Measurement of thinking skills

There seems to be some contention about how to measure thinking skills and even disagreement about what the term thinking means (Allen, 2004). In general, critical thinking describes the process of analysing and evaluating information using certain cognitive skills to reach a specific goal or achieve a specific result (Elder & Paul, 1996; McPeck, 1981). Definitions of critical thinking vary according to specific tasks and domains of learning, but the majority involve words such as reasoning, reflection, judgment and evaluation. Much of what we think of as critical thinking involves the learner being self-directed and able to transfer knowledge and skills across a wide array of domains of learning.

Critical thinking and Higher Order Thinking Skills

Critical thinking skills are closely linked with higher order thinking skills and deeper levels of learning. Often the idea of teacher as facilitator or collaborator is promoted with the endorsement of critical thinking skills (Martinez, 2014). This concept is one that has become associated with 'flipping the

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

classroom' which technology has enabled for students (Rutherfoord & Rutherfoord, 2013). McMahon (2009) found that students operating in a technology-rich environment were able to demonstrate higher order thinking skills but students with higher computer programming skills demonstrated greater ability to transfer these skills than those who had lower programming skills. McMahon conducted his study with a Year Nine student cohort in a metropolitan, independent girls' school in Western Australia using a sample size of approximately 150 students. The school had been implementing a notebook computer program for nine years, in which all students in Years Five through to Year Ten use their notebooks across all learning areas every day at school. The Year Nine cohort constituted students that had between one and five years' exposure to the technology-rich learning environment. Overall, McMahon found that students with better computing skills demonstrated a higher level of critical thinking (2009, p. 280).

HOTS and technology

Higher Order Thinking Skills and the use of technology has been targeted as an area for research by some (Duan, 2012; Pecka, 2014). There have been attempts to measure the effectiveness of technology and the development of higher order thinking skills (Mojica, 2010; Zenisky, 2014). This study, conducted by Mojica, was with 105 eighth grade students at a suburban middle school in New York State. They participated in a seven-month-long project involving the ordered effects of the technology education units of Lego® Mindstorms™ NXT Robotics System, Digital Storytelling with Microsoft Windows Movie Maker, and the Marble Maze Challenge on the higher-order critical thinking skills as measured by the Cornell Critical Thinking Test, Level X. Her conclusion was that technology did not have a statistically significant effect on students' higher-order critical thinking skills, nor did the effects vary by gender, age, or the learner's academic ability.

However, this area of research relating to the use of technology and the development of higher order thinking is not one that has been studied systematically and it is an area that requires more exploration. The taxonomies of learning as outlined by Benjamin Bloom (1956) have become part of the teaching and learning pedagogies promoted around the globe by educational organizations. These levels of understanding have been embedded in our curriculum documents. They are an expected part of the thinking tools scaffolded by teachers in classrooms.

Theory - Why theorize technology and education

The use of a recognized theoretical base for research has been identified as imperative for educators to gain a greater understanding of what is happening with the use of technology in education, whether it is indeed changing, transforming or promoting learning, and how it can foster deeper learning or critical thinking in secondary school students. Theory-based research provides a common language for discussion and thus a common understanding of the findings and a basis for generalities and further investigations. A theoretical base for exploring the complexities of emerging technologies in education and higher order thinking skills is vital for research to be a robust and pertinent addition to the body of literature available.

Need of theory

Theories of learning are necessary for us to understand if and how these emerging technologies are enhancing learning, or nurturing deeper knowledge and driving us towards on-going understandings of life. Gibson (2001) outlines the assumptions that are commonplace when discussing technology and education. His list includes the ideas that technology is ultimately good; all learners are excited and comfortable about the use of technology; technology use in classrooms disturbs the ecology of the dynamics of teaching and technology use can lead to change (Gibson, 2001 p. 38).

Theories used by researchers in the field

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

It is clear from the literature that evaluating the use of technology in education does not have a strong theoretical base (Graham, 2011; Howard & Maton, 2011; Oliver, 2005). Depending on what aspect of the technology is being evaluated, the educational theories that are being used vary from Sociocultural Theory (Bozalek, 2014; Gee, 2010; *Technology in Education: Looking Toward 2020*, 1988; Whipp, Eckman, & van den Kieboom, 2005), Affordance Theory (Churchill, Fox, & King, 2012; J. Hopkins, 2013; Parmaxi & Zaphiris, 2014), Constructivist Theory (Kafai & Resnick, 2012; Kirkley, 2000), Empirical Theory and Discourse Analysis Theory (Mulcahy, 2014; Rambe, 2012; Schneider & Smith, 2014). Much of the pedagogy that has been developed for digital technologies has been based on the design of courses, collaborative online learning and what technology can replace in the traditional school setting. This relies heavily on the idea that there will be a paradigm shift in education with the introduction of global classrooms and the assumption that learning that can occur anytime, anywhere (Lock, 2014). Sharples (2007) proposed that a theory for mobile learning be adopted which could encompass the fact that learning can take place anytime anywhere.

Bennett and Oliver discuss the "missed opportunities in learning technology research" (S. Bennett, and Oliver, Martin, 2011) and provide a provocative debate on why researchers should be concerned with theory. They deliver an outline of case studies that have had their focus on aspects of technology in education research such as mutual informing theory and practice; reframing design problems and theory to frame research within a wider context. These case studies demonstrate the idea that without a theory base it is difficult to identify an "orientating framework to shape data collection and analysis by providing a lens that determines which aspects of the context should be attended to and why they are important to understanding the phenomenon" (Bennett & Oliver, 2011, p. 185).

Educational Theory

The wider educational implications of the impact of technology on teaching and learning in secondary schools are significant (Selwyn, 2002). The need for further research on the use of technology in education would be of benefit to educational theory and provide a framework for the development of learning. Such a framework would either rely solely on technology for their delivery or deliberately integrate technology into the learning process. Prensky (2012) states that as technological innovation and advances are part of the fabric of our social structures and students are immersed in this technologically driven culture that it is imperative that educators harness these technologies in teaching and learning arenas. Selwyn (2011) concluded that improvement in education must be digitally driven and has to be something that is both expected, assumed and central to the evolution of education.

TPACK

TPACK is provided as a framework for educators to use to integrate technology, pedagogy and content knowledge into educational settings. Koehler and Mishra admit that this framework is based on Shulman's work (Koehler & Mishra, 2005) but does not have a strong theoretical base, although its beginning was based on a design experiment theory (P. K. Mishra, M. J., 2006). As a framework, TPACK has been instrumental in bringing the three areas of technology, pedagogy and content into alignment for some teachers and some areas.

Learning theories and their application to technology in education is an area that has become significant in the research field. These learning theories proposed by researchers (Berardi, 2013; Harasim, 2012; Pachler, 2013; Singh, 2014) provide an understanding of the ways in which we learn and how this relates to technologies. Harasim (2012) believes that it is "critical and timely" that we address the intersections between learning and technology (p. 2) and asserts that learning and technology are integral to human development (p. 169). Harasim claimed that this intersection is at an early stage and requires a theory to guide and advance the practice and research in this field

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

towards "bolder visions and strategies" (p. 169).

TPACK and technology tools

Jamie McKenzie in 'From Now On' (2004) contested that for Australian educators the "choice of tools to support student learning should come after the designer has clarified learning goals". This is what TPACK has instigated by introducing a means for educators to articulate how they can use technology (T) and incorporate this with their pedagogy (P) in that teaching and improve the content (C) and thus student knowledge (K), (P. K. Mishra, M. J; Kereluik, K., 2009). However, Thompson challenged those who deemed that technology would mean teachers become obsolete (1999) and proposed that the 21st-century learner will use technology as one of the many tools that can facilitate learning. It is this conceptualized holistic view of education that has provided educators with grounds for an argument that can incorporate technology, but not be swallowed up by, dominated by, or succumb to the pressures of the augmentative proliferation of technology, when applied to education.

Issues with theories and technologies

The idea that technology is a 'tool' is prevalent (Arntzen, 2008; Tapscott, 1999) and has found its way into some curriculum documents across the globe. Feenberg (2012) states "the tools we use to shape our way of life in modern societies where the technique has become all pervasive" (p. 2). He believes that means and ends cannot be separated and that how we do things determine who we are.
Feenberg also postulates that the philosophical question of technology is that technology is the force that both improves and develops our civilization. It is both master and slave and at its core is the belief that it is neutral, efficient and expedient to the forward march of human progress.

Researchers such as Bennett and Oliver (2011) and Mishra and Koehler (2006) posit that most research has focused on matters of practical implementation and design rather than evidence or theory. Orlikowski and Iacono (2001) also observed that this field of research is under-theorised (p. 121). Conole and Oliver (2002) celebrate the multidisciplinary aspect of the research field into technologies but state that "if we are to capitalise on the richness of expertise, it is necessary to work towards a clear theoretical underpinning that allows these diverse cultures to engage with and develop the use of learning technology" (p. 2). Their premise is that theory needs to be pragmatic, related closely to practice and to be transferable to real-life classroom situations.

Gaps in our knowledge

Oliver identified what he termed a 'significant gap' in our ability to apply theory to the use of technologies in education (Oliver, 2013) and that it is this that has led to our current incapacity to articulate the importance of technology for education. It is a contributor to what appears to be a dearth in explanations or the provision of "poor explanations" (Oliver, 2013 p. 31). The notion that theory is fundamental to our understanding of learning is clear. However, what is not so clear is the link between technology and learning. Oliver proposes that there is an "overemphasis" of technology and its application to learning and that our understanding of how learning occurs with technology is not substantiated by theoretical underpinnings (Oliver, 2011).

Technology and pedagogy

In questioning technology for the purposes of teaching, learning and thinking in education must examine the pedagogy of these technologies to ensure that they are achieving the aims of mass education (Wijekumar, 2006). If technologies can enhance and nurture and encourage critical thinking in students, then their implementation into teaching practices should be embraced. It is rational for educators to implement technological advances into educational settings and attempt to remain abreast of these advances in technology. The assumption that educators must embrace their possibilities, however ubiquitous, to remain relevant and in step with modern society is logical. As

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Oliver and Conole (2006) conclude, e-learning remains "complicated, fast-moving and important" and we cannot change that nor can we solve it (*Contemporary perspectives in e-learning research : themes, methods, and impact on practice*, 2006).

Methodology and Research Design

The purpose of the case study was to explore the use of technologies in secondary school English Language Arts education classrooms and whether they were nurturing higher order thinking skills for students. The case study was made up of three phases: Preparation; Data Collection; and Analysis. The study explored whether emerging technologies fostered the development of higher order thinking. A qualitative research basis was used to conduct the research. The study relied on the notions of knowledge formulation and gathering as a social construction with a particular interest in the opinions and perspectives of all the participants.

This was a situated case study that located the researcher in with students and teachers in a secondary school in the state of Victoria in the country of Australia. The conversations, interviews, observations, video and voice recordings and other data collection were used to inform the case study with a data set that was used for analysis. The interpretation and representation of this knowledge and data occurred from the context of this natural setting and the intrinsic meanings that the participants brought to the study were be included in the research (2005).

In the study, the participants were primarily chosen on the basis of convenience to the researcher and are all either students or teachers at the school where the researcher was employed. One of the main considerations for the choice of participants was access to both English Language Arts classrooms and to teacher interest in the study. A major consideration was that the three classes must be English Language Arts classrooms from the middle school area as this was the teaching expertise of the both the researcher and the teacher participants. The teaching staff were then selected firstly on the basis of their availability and willingness to participate in the Study and then for their predilection for technology.

The research design was based on the qualitative study design process. It included journal keeping by the researcher, semi-structured interviews of both students and teachers, a Higher Order Thinking Skills checklist(s), observations of classroom practice and where practical and possible, audio and visual recordings of selected lessons. The researcher kept a written journal during the time of the case study which was used as part of the data collection. A Focus Group for teachers was held at the conclusion of the study as well as a Focus Group for the students.

The research design was based on an understanding that undertaking a case study will facilitate a rich set of data that will provide a basis for discussion around the problem of technology in education and the promotion of higher order thinking skills. The researcher was purposefully looking for differences in attitudes, understandings, and articulation of higher order thinking in both students and teachers. The Study was both student and teacher orientated.

This case study consisted of three classes with three different teachers over one unit of work within one semester. The study was based on observations of at least one period per week with each class. The observation of classes occurred over a six-week period for each class as this is the typical length of a unit of work in the English Language Arts domain. The choice of teachers was based on the following criteria: one who was technologically adept and used it regularly in class; one teacher who had some skills and used technology as part of their teaching repertoire but was not necessarily using it every lesson; and one teacher who either deliberately did not use technology at all, or rarely, whether because of skill or because of their pedagogical choice.

The choice of the Unit of Work being undertaken at the time of the study was not significant as the

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

study was based on the availability and choice of teacher and their willingness to be involved in the study. Class observation and/or participation in each class at least one period per week over the teaching of the unit within the semester was the optimal solution to the collection of data for this case study.

The researcher ensured that an information provision interview with the teachers involved occurred prior to the beginning of the Unit of Work to ensure that they understood the purpose of the study. During that session, the researcher outlined the process of the study and what would be expected of the teacher participant. The researcher informed the teacher that audio and visual recordings of some of the lessons would occur, but in consultation with the classroom teacher. Questioning and interacting with the class and particular students was planned to elicit the understandings and opinions of the use of technology in English Language Arts to foster their higher order thinking skills.

Using this range of data collection, the researcher was able to draw conclusions regarding the use of technology to promote higher-order thinking based on the information collected. The pre-interviews with each teacher took no longer than thirty (30) minutes and focused on the use (or not) of technology and how they intended to demonstrate the purposeful development of higher order thinking skills for particular aspects of the Unit of Work. The teacher had the option to develop these with the researcher or would propose to cultivate higher order thinking skills in deliberate ways independent of the researcher's input.

Preliminary Findings and Discussion

The study found that there are three main areas of concern when using technology in English Language Arts classrooms. The first is speed. Students want to get things done quickly. This is not about efficiency or effectiveness, but about just getting things done. The second area of concern is that many teachers make the assumption that if students are engaged that they are learning. This is not always true and the students themselves were aware that while the use of technology could be “fun” it was not necessarily learning. The third area of concern is that what students bring to technology is what determines how effective technology is for their learning. These are broad areas of concern but were clearly apparent in the classrooms that had been observed with middle school students. Learning seemed to occur when dialogue with each other and the teacher was at the center of all activities.

The study had as a hypothesis that technology use in middle school English Language Arts classrooms did not necessarily improve the potential for students to develop their higher order thinking skills. However, what was observed is that the ability of the student to apply higher order thinking skills could be somewhat dependent on the skill of the teacher to develop thinking skills alongside technology use. Similar issues that were found in the literature emerged. The teacher who was most comfortable and familiar with the development of thinking skills and the transferal of these skills into writing and tangible outcomes had the most success with demonstrating higher order thinking skills. Likewise, the teacher who was confident with the use of technology and had an astute awareness of both its limitations and potentialities could use the technology to enhance the student's ability to think more critically. What was clear from all the classrooms was that much of the thinking ability of students had to have had some grounding in either natural ability of students or pre-existing thinking skills for them to be able to build on them. Technology, of itself, was not fostering these critical thinking skills for students.

As a tool, it enabled students to explore the learning at a level they felt comfortable with. In one classroom the use of Windows Media Player was employed to demonstrate their knowledge of film techniques. The required outcome was to make a short film using at least five film techniques in one chosen film genre to validate their understanding of the value of film techniques and their role in analyzing film as a text. This was highly successful, with students successfully incorporating elements

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

of film into their short films beyond what was expected. The technology use was part of the demonstration of the thinking processes employed, but it is not clear what role pre-existing student ability took in this and whether any students actually improved their ability to think more critically about films and the benefits of being able to analyse them.

The use of online computer games such as 'Kahootz' in the English Language Arts classroom did little more that test comprehension skills. While this has some benefits, the development of higher order thinking was not particularly evident. High engagement with the game was clear and each student participated in the game with enthusiasm. The competitive side of the game was evident and the need to reply with speed and accuracy meant high levels of concentration. However, the students themselves admitted that the game was more entertaining than it was a learning tool. Once again, the success of the game in terms of comprehension was determined by the skill of the teacher in composing the comprehension questions for the students.

What was particularly interesting is that the students themselves are aware of the benefits and drawbacks of the use of technology in classrooms as learning tools. Many were able to easily identify that use of laptops and phones were prone to distraction more than providing a means for greater engagement and information gathering on topics of learning. More than one student was able to articulate that the use of technology was not of importance, it was the subject matter and how the teacher presented and interacted with it for them. If they were aware of the purpose of what it was that they were learning, clearly articulated by the teacher, they felt they were more likely to accept and understand the learning outcomes and achieve these.

The students who had learning difficulties were most easily distracted and involved in self-distraction by the use of technology. The students who were abler were similarly most distracted and involved in self-distraction with the use of technology. This supports the idea that schools are able to differentiate some learning but not reach all student all the time. 21st-century students are still interested in being able to learn and be involved in the learning process. It appears that whether they are able to improve their thinking skills is secondary for them. The need to successfully reach the required outcome was paramount for the highly able students. It was of no concern to most students with learning difficulties, regardless whether the technology was being used or not.

Some students with learning difficulties recognized that writing slowly and by hand improved their thinking and learning. They chose not to use technology because the speed of the task was detrimental to their overall ability to achieve an acceptable grade for them. The speed of technology was an issue that students raised regularly – either as a benefit to them or as stated, not helpful for their learning outcomes. The idea of hand-writing was something that was thought to be obsolete. Similar to having to read information, whether paper-based, or on screens. The reading ability of the student was closely aligned to the ability of the student to achieve successful outcomes for their learning. Technology was not helping students to become better readers and the link between this and thinking became clearer as the study progressed.

References

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Abrams, S. S. (2014). *Integrating Virtual and Traditional Learning in 6-12 Classrooms: A Layered Literacies Approach to Multimodal Meaning Making*: Routledge.

Allen, M. (2004). *Smart thinking : skills for critical understanding and writing* (2nd ed. ed.). South Melbourne, Vic.: Oxford University Press.

Arnone, M. P., Small, R. V., Chauncey, S. A., & McKenna, H. P. (2011). Curiosity, interest and engagement in technology-pervasive learning environments: a new research agenda. *Educational Technology Research and Development, 59*(2), 181-198. doi:10.1007/s11423-011-9190-9

Arntzen, J., Don Krug, Zhengyan Wen. (2008). ICT literacies and the curricular conundrum of calling all complex digital technologies "Tools". *International Journal of Education and Development using Information and Communication Technology, 4*(4), 6-14.

Aslan, S. a. C. M. R. (2013). Educational Technologists: Leading Change for a New Paradigm of Education. *TechTrends, 57*(5), 18-24.

Ben-Jacob, M. G. a. T. E. B.-J. (2013). Perspectives on online and onsite pedagogy the impact of technology now and in the future. *Art and Design Review, 1*(1), 1-5.

Bennett, S., and Oliver, Martin. (2011). Talking back to theory: the missed opportunities in learning technology research. *Research in Learning Technology, 19*(3), 179-189. doi:10.1080/21567069.2011.624997

Bennett, S., & Maton, K. (2010). Beyond the 'digital natives' debate: Towards a more nuanced understanding of students' technology experiences. *Journal of Computer Assisted Learning, 26*(5), 321-331. doi:10.1111/j.1365-2729.2010.00360.x

Berardi, V. a. G. B. (2013). *A learning theory approach to using capture technology in teaching ideas from basic lecture capture to student created content*. Paper presented at the Proceedings of the Information Systems Educators Conference, San Antonio, Texas, USA.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H. and Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals; Handbook I: Cognitive domain*. London: Longmans.

Bozalek, V., Ng'ambi, Dick, Wood, Denise. Herrington, Jan, Hardman, Joanne, Amory, Alan. (2014). *Activity Theory, Authentic Learning and Emerging Technologies: Towards a transformative higher education pedagogy*: Routledge.

Christensen, C. M., Horn, M. B., & Johnson, C. W. (2008). *Disrupting Class : How Disruptive Innovation Will Change the Way the World Learns*. New York: McGraw-Hill.

Churchill, D., Fox, B., & King, M. (2012). Study of Affordances of iPads and Teachers' Private Theories. *International Journal of Information and Education Technology, 2*(3), 251. doi:http://dx.doi.org/10.7763/IJIET.2012.V2.122

Cochrane, T. D. (2014). Critical success factors for transforming pedagogy with mobile Web 2.0. *British Journal of Educational Technology, 45*(1), 65-82.

Conole, G. O., M. . (2002). Embedding Theory into Learning Technology Practice with Toolkits. *Journal of Interactive Media in Education, 2*(8), 1-28.

Contemporary perspectives in e-learning research : themes, methods, and impact on practice. (2006). (G. a. O. Conole, M. Ed.). London: Routledge.

Contributing to educational change: Perspectives on research and practice. (1988). (P. W. Jackson Ed.). Berkeley, Calif.: McCutchan Publishing Corporation.

Cox, M. J., Niederhauser, D. S., Castillo, N., McDougall, A. B., Sakamoto, T., & Roesvik, S. (2013). Researching IT in education. *Journal of Computer Assisted Learning, 29*(5), 474-486. doi:10.1111/jcal.12035

Denzin, N. a. L., Y. S. (Eds.). (2005). *The Sage Handbook of Qualitative Research* (N. a. L. Denzin, Y. S. Ed.). Thousand Oaks, Calif.: Sage.

Derry, J. (2007). Epistemology and conceptual resources for the development of learning technologies. *Journal of Computer Assisted Learning, 23*(6), 503-510.

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Duan, J. (2012, 14-17 July 2012). *Research about technology enhanced higher-order thinking.* Paper presented at the Computer Science & Education (ICCSE), 2012 7th International Conference on.

Elder, L., & Paul, R. (1996). Critical Thinking: A Stage Theory of Critical Thinking: Part I. *Journal of Developmental Education, 20*(1), 34-35. doi:10.2307/42775704

Facer, K. S., R. (2010). The next 25 years? Future scenarios and future directions for education and technology. *Journal of Computer Assisted Learning, 26*(1), 74-93. doi:10.1111/j.1365-2729.2009.00337.x

Feenberg, A. (2012). *Questioning Technology* Retrieved from http://latrobe.eblib.com.au/patron/FullRecord.aspx?p=165092

Friesen, N. (2008). Critical Theory: Ideology Critique and the Myths of E-Learning. *Ubiquity, 2008*(June), 2. doi:10.1145/1386858.1386860

Fullan, M., & Donnelly, K. (2013). *Alive in the swamp: Assessing digital innovations*. Retrieved from London:

Gates, B. (2005). High Schools are Obsolete. *Vital Speeches of the Day, 71*(13), 396-399.

Gee, J. P. (2010). A situated sociocultural approach to literacy and technology. Retrieved from http://www.jamespaulgee.com/publications

Gerber, S., & Scott, L. (2011). Gamers and gaming context: Relationships to critical thinking. *British Journal of Educational Technology, 42*(5), 842-849. doi:10.1111/j.1467-8535.2010.01106.x

Gettler, L. (2010, 29th September 2010). Big Googler is doing the thinking for you, Feature Article. *Sydney Morning Herald*.

Gibson, I. W. (2001). At the intersection of technology and pedagogy: considering styles of learning and teaching. *Journal of Information Technology for Teacher Education, 10*(1-2), 37-61. doi:10.1080/14759390100200102

Goodrich, R. A. (2014). Education for the Human Brain: A road map to natural learning in schools. *Educational Philosophy and Theory*, 1-4. doi:10.1080/00131857.2014.906937

Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Computers & Education, 57*(3), 1953-1960. doi:10.1016/j.compedu.2011.04.010

Greenhow, C. (2008). @TEOTD JM2C : a look at the research on digital literacies and today's learners. *Learning and Leading with Technology, Dec/Jan 2008/2009*.

Harasim, L. (2012). *Learning theory and online technologies*. New York: Routledge.

Harris, J. B. H., Mark J. (2011). Technological pedagogical content knowledge (TPACK) in action a descriptive study of secondary teachers' curriculum based technology-related instructional planning. *Journal of Research on Technology in Education, 43*(3), 211-229.

Hartley, S. C., M.; Cook, N. (2013). *Dragging the digital chain: planning the pedagogical and digital direction of Oakhill College*. Paper presented at the ICERI2013 Proceedings, Seville, Spain, November.

Hertz, M. B. (2012). The Problem with 21st Century education.

Hopkins, J. (2013). Assembling affordances: towards a theory of relational affordances. *Selected Papers of Internet Research, 14*, 1-5.

Hopkins, M. (1997). Technologies as tools for transforming learning environments. In T. King (Ed.), *Technology in the classroom : a collection of articles* Cheltenham, Vic.: Hawker Brownlow.

Howard, S., & Maton, K. (2011). Theorising knowledge practices: a missing piece of the educational technology puzzle. *Research in Learning Technology, 19*(3).

Hwang, G.-J., Hung, Chun-Ming, Chen, Nian-Shing. (2013). Improving learning achievements, motivations and problem-solving skills through a peer assessment-based game development approach. *Educational Technology Research and Development*, 1-17. doi:10.1007/s11423-013-9320-7

Hwang, G.-J., & Tsai, C.-C. (2011). Research trends in mobile and ubiquitous learning: a review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology, 42*(4), E65-E70. doi:10.1111/j.1467-8535.2011.01183.x

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Jackson, M. J., Helms, M. M., Jackson, W. T., & Gum, J. R. (2011). Student Expectations of Technology-Enhanced Pedagogy: A Ten-Year Comparison. *Journal of Education for Business, 86*(5), 294-301. doi:10.1080/08832323.2010.518648

Kafai, Y. B., & Resnick, M. (2012). *Constructionism in Practice : Designing, Thinking, and Learning in A Digital World* Retrieved from http://latrobe.eblib.com.au/patron/FullRecord.aspx?p=1074828

Kirkley, J. D., Thomas. (2000). Expanding beyond a cognitivist framework. *ACM Journal of Computer Documentation, 24*(1), 21-24. doi:10.1145/330409.330412

Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? *Journal of Educational Computing Research, 32*(2), 131-152.

Lantz-Andersson, A., Vigmo, S., & Bowen, R. (2013). Crossing boundaries in Facebook: Students' framing of language learning activities as extended spaces. *International Journal of Computer-Supported Collaborative Learning, 8*(3), 293-312. doi:10.1007/s11412-013-9177-0

Li, S. C. (2010). Social capital, empowerment and educational change: a scenario of permeation of one-to-one technology in school. *Journal of Computer Assisted Learning, 26*(4), 284-295. doi:10.1111/j.1365-2729.2010.00350.x

Lock, J. V. (2014). Designing learning to engage students in the global classroom. *Technology, Pedagogy and Education*, 1-17. doi:10.1080/1475939X.2014.946957

Mabel, C. P. O. O., Olinzock, A. A., & Okojie-Boulder, T. C. (2006). The Pedagogy of Technology Integration. *Journal of Technology Studies, 32*(2), 66-71.

Marshall, J. W. (2002). *Learning with Technology : Evidence that technology can, and does, support learning : White Paper*. Retrieved from

Martin, O. (2007). The problem with representing knowledge with and about technology. *Research in Learning Technology, 15*(2), 101-102.

Martinez, M., McGrath, Dennis. (2014). Technology alone won't transform teacher to facilitator. *Phi Delta Kappan, 96*(1), 41-45. doi:10.1177/0031721714547861

McKenzie, J. (2004). Stuffing technology into the curriculum. *The Educational Technology Journal, 13*(8), 1-6.

McPeck, J. (1981). *Critical thinking and education*. Oxford: Martin Robertson & Company Ltd.

Mishra, P., Fahnoe, C., & Henriksen, D. (2013). Creativity, Self-Directed Learning and the Architecture of Technology Rich Environments. *TechTrends, 57*(1), 10-13. doi:http://dx.doi.org/10.1007/s11528-012-0623-z

Mishra, P., & Koehler, M. J. (2008). *Introducing Technological Pedagogical Content Knowledge*. Paper presented at the Annual Meeting of the American Educational Research Association, New York City.

Mishra, P. K., M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017–1054.

Mishra, P. K., M. J; Kereluik, K. (2009). The song remains the same looking back to the future of educational technology. *TechTrends, 53*(5), 48-53.

Mojica, K. D. (2010). *Ordered effects of technology education units on higher-order critical thinking skills of middle school students.* (Doctor of Professional Studies in Computing D.P.S.), Pace University, Ann Arbor. ProQuest Dissertations & Theses Global database.

Mulcahy, C., Mulcahy, DE, Mulcahy, DG. (2014). *Discourses on Pedagogy, Praxis and Purpose in Education*: Routledge.

OECD. (2015). *Students, Computers and Learning*: PISA, OECD Publishing.

Oliver, M. (2005). The Problem with Affordance. *E–Learning, 2*(4), 402-413. doi:10.2304/elea.2005.2.4.402

Oliver, M. (2011). Technological determinism in educational technology research: some alternative ways of thinking about the relationship between learning and technology. *Journal of Computer Assisted Learning, 27*(5), 373-384. doi:10.1111/j.1365-2729.2011.00406.x

Oliver, M. (2013). Learning technology: Theorising the tools we study. *British Journal of Educational Technology, 44*(1), 31-43. doi:doi:10.1111/j.1467-8535.2011.01283.x

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Orlikowski, W. J., & Lacono, C. S. (2001). Research Commentary: Desperately Seeking the 'IT' in IT Research--A Call to Theorizing the IT Artifact. *Information Systems Research, 12*(2), 121.

Pachler, N. (2013). Perspectives on and theories of learning with digital technologies. In M. a. P. Leask, N. (Ed.), *Learning to teach using ICT in the Secondary school* (pp. 1-17). London: Routledge.

Parmaxi, A., & Zaphiris, P. (2014). *Affordances of social technologies as social microworlds*. Paper presented at the CHI '14 Extended Abstracts on Human Factors in Computing Systems, Toronto, Ontario, Canada.

Pecka, S. L. (2014). *Evaluating higher order thinking in online discussions.* (Doctorate Ph.D.), University of Nebraska Medical Center, Ann Arbor. ProQuest Dissertations & Theses Global database.

Peluso, D. C. C. (2012). The fast-paced iPad revolution: Can educators stay up to date and relevant about these ubiquitous devices? *British Journal of Educational Technology, 43*(4), E125-E127. doi:10.1111/j.1467-8535.2012.01310.x

Postma, D. (2014). Education as change: Educational practice and research for transformation. *Education as Change, 18*(1), 3-7. doi:10.1080/16823206.2013.847024

Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon, 9*(5), 3-6.

Prensky, M. (2012). *From digital natives to digital wisdom : hopeful essays for 21st-century learning*. Moorabbin, Vic.: Hawker Brownlow.

Rambe, P. (2012). Critical discourse analysis of collaborative engagement in Facebook postings. *Australasian Journal of Educational Technology, 28*(2), 295-314.

Robey, D., Raymond, Benoit & Anderson, Chad. (2012). Theorizing Information Technology as a Material Artifact in Information Systems Research. In B. A. N. Paul M. Leonardi, and Jannis Kallinikos (Ed.), *Materiality and Organizing: Social Interaction in a Technological World* (pp. 217-236). Oxford: Oxford University Press.

Roblyer, M. D. (2005). Educational Technology Research That Makes a Difference: Series Introduction. *Contemporary Issues in Technology and Teacher Education, 5*(2), 192-201.

Rutherfoord, R. H., & Rutherfoord, J. K. (2013). Flipping the classroom. 19. doi:10.1145/2512276.2512299

Saavedra, A. R., & Opfer, V. D. (2012). Learning 21st-century skills requires 21st-century teaching. *Phi Delta Kappan, 94*, 8+.

Schneider, S. B., & Smith, D. (2014). Constructing and Reconstructing a Critical Discourse and Pedagogy of Techno-Knowledge. *Educational Studies, 50*(1), 3-7. doi:10.1080/00131946.2014.867218

Scott-Webber, L. (2012). Institutions, Educators, and Designers: Wake Up!: Current Teaching and Learning Places Along with Teaching Strategies Are Obsolete-Teaching Styles and Learning Spaces Must Change for 21st-Century Needs. *Planning for Higher Education, 41*(1), 265-277.

Selwyn, N. (2002). *Telling tales on technology : qualitative studies of technology and education*. Aldershot: Ashgate Publishing.

Sharples, M. J. T. G. V. (2007). A theory of learning for the mobile age *The SAGE handbook of E-Learning Research*. London, England: SAGE Publications, Ltd.

Singh, E. (2014). Learning theory and online technologies. *Open Learning: The Journal of Open, Distance and e-Learning*, 1-4. doi:10.1080/02680513.2013.864550

Sokolov, M. (2001). Technology's impact on society: The issue of mass-customized education. *Technological Forecasting and Social Change, 68*(2), 195-206. doi:http://dx.doi.org/10.1016/S0040-1625(99)00118-3

Starkey, L. (2011). Evaluating learning in the 21st century: a digital age learning matrix. *Technology, Pedagogy and Education, 20*(1), 19-39. doi:10.1080/1475939x.2011.554021

Tapscott, D. (1999). Educating the Net generation. *Educational Leadership, 56*(5), 6-11.

Technology in Education: Looking Toward 2020. (1988). Technology in Education Series, R. S. Z. Nickerson, P.P. (Ed.)

Author Name: Lucy Edwards
Contact Email: ledwards@highview.vic.edu.au

Thompson, A. (2010). Is technology killing critical-thinking skills? *Learning and Leading with Technology, 1*, 6-7.

Thompson, S. (1999). Teachers won't be obsolete in the future. *Technology in Government, 6*(4), 9.

Vander Ark, T. (2012). *Getting smart: how digital learning is changing the world*. San Francisco: Jossey-Bass.

Weigel, V. B. (2002). *Deep Learning for a Digital Age: Technology's Untapped Potential To Enrich Higher Education*. California: Jossey-Bass.

What is 21st Century Education? (2010). Retrieved from http://www.21stcenturyschools.com/what_is_21st_century_education.htm

Whetten, D. A. (1989). What Constitutes A Theoretical Contribution? *Academy of Management. The Academy of Management Review, 14*(4), 490.

Whipp, J. L., Eckman, E. W., & van den Kieboom, L. (2005). Using Sociocultural Theory to Guide Teacher Use and Integration of Instructional Technology in Two Professional Development Schools. *Journal of Computing in Teacher Education, 22*(1), 37-43. doi:10.1080/10402454.2005.10784534

Wijekumar, K. J., Bonnie J.F. Meyer, Diane Wagoner, and Lon Ferguson. (2006). Technology affordances: the 'real story' in research with K-12 and undergraduate learners. *British Journal of Educational Technology, 37*(2), 191-209.

Wu, Y.-T. (2013). Research trends in technological pedagogical content knowledge (TPACK) research: A review of empirical studies published in selected journals from 2002 to 2011. *British Journal of Educational Technology, 44*(3), E73-E76. doi:10.1111/j.1467-8535.2012.01349.x

Xin, B. (2010, 18-22 Aug. 2010). *Affordance of Ubiquitous Learning through Cloud Computing.* Paper presented at the Frontier of Computer Science and Technology (FCST), 2010 Fifth International Conference on.

Zenisky, A. L., Lisa A. Keller, and Xi Wang. (2014). *De-constructing Constructs: Evaluating Stability of Higher-Order Thinking Across Technology-Rich Scenarios*. Paper presented at the Annual meeting of NCME, Philadelphia, PA, April 4-6, 2014.