Ann Marcus-Quinn · Tríona Hourigan
Editors

Handbook on Digital Learning for K-12 Schools

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Preface

Old Debates, Unanswered Questions, Better Futures

This is a very timely book. Outside of schools digital technologies have impacted on virtually every aspect of our lives. It is hard to imagine life just a decade or so ago before Google, Facebook, Instagram, Snapchat, Twitter, and so on. Yet evidence from a recent Organisation for Economic and Co-operation Development (OECD) (2015) report claims the reality inside schools is very different. Schools lag considerably behind the transformative promise of new digital technologies. According to the OECD's (2015) international comparative analysis of PISA data:

> Students who use computers moderately at school tend to have somewhat better learning outcomes than students who use computers rarely. But students who use computers very frequently at school do a lot worse in most learning outcomes, even after accounting for social background and student demographics (p. 3).

The study also found countries that had invested heavily in digital forms of education showed no appreciable improvements in student achievement in Reading, Mathematics or Science. While the findings grabbed headlines around the world and fuelled concerns of many parents and caregivers that today's "screenagers" risk their physical, intellectual and emotional development by spending far too much time playing with digital devices, debates about the effects of technology on schooling are not new. Indeed, there has been a long history of claims, counter-claims and moral panics about the impact of technology on teaching and learning.

Almost 20 years ago the level of public concern over the growth of new technology in education was heightened when the *Atlantic Monthly* strongly attacked the spurious evidence supporting the "computer delusion" in schools (Oppenheimer, 1997). After an exhaustive investigation, Oppenheimer (1997) concluded:

> There is no good evidence that most uses of computers significantly improve teaching and learning (p. 45).

This conclusion gave further ammunition to neoconservatives, including those within the education profession, who argued that it was scandalous so much money had been allocated for computers and Internet access with so little serious evaluation (Armstrong & Casement, 1998). More alarmingly, Armstrong and Casement (1998) claimed:

> A generation of children have become the unwitting participants in what can only be described as a huge social experiment (p. 2).

The problem is that such blanket statements, including the findings of last year's OECD report, give insufficient attention to the instructional context. Ironically most of these headline grabbing reports are guilty of assigning too much attention to the technology itself, which is precisely what they accuse the proponents of hyperbole surrounding the digital revolution of doing. Put another way, it is techno-centric to think that technology alone can significantly improve teaching and learning, as a complex constellation of factors or confounding variables contribute to better educational outcomes. The key point is that the computer should not be seen as a single entity or monolithic machine that teachers use within schools in a uniform manner.

As this book illustrates through a diverse range of chapters from countries around the world, new digital technologies can be deployed in the service of teaching and learning across many different instructional contexts using a wide variety of applications. Thus, sweeping generalizations about the impact of digital technology on teaching and learning are unhelpful as far more nuanced understandings are required, which combine both numbers and narratives. In the best traditions of the scholarship of practice this book gathers together some insightful narratives and case studies on digital teaching and learning in K-12 schools. It provides a delightful taste of the diversity of digital learning as it is currently practised around the world. In this respect the book offers a strong counter-narrative to the OECD (2015) report by showing how many schools, teachers and students are embracing the transformative promise of new digital technologies.

Despite this important contribution to the field, it is hard to disagree with the OECD's (2015) conclusion that there are still many questions unanswered. For example, how do we mainstream local case studies in digital teaching and learning on a more systemic, scalable and sustainable basis? What are the real problems that teachers and schools currently face which could be solved through new digital technologies? What will be the long-term impact or distal effects of digital teaching and learning on K-12 schools? This last question is mindful of Amara's Law:

> We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run (Gammack, Hobbs, & Pigott, 2011, p. 368).

In many respects, old debates about the impact of technology on learning rekindled by the recent OECD (2015) report help to raise much bigger questions. They challenge the rhetoric of "Ed-Tech Speak" (Selwyn, 2015) and can be used to promote deeper thinking about broader social imaginaries, alternative scenarios for schooling and more radical futures in the service of big ideas (Brown, 2015). One thing is certain: the future will be different. Nevertheless, the bigger question remains in terms of what type of K-12 school system and educational outcomes do we want new digital technology to help serve in the future? The answer to this question needs to go beyond simple dichotomies of illusory hype or pessimistic Armageddon. In Postman's (1993) terms, "Every technology is both a burden and a blessing; not either-or, but this-and-that" (p. 5).

This is why in the language of possibility—albeit from a more critical perspective—we need to continually question and justify the faith politicians, industry leaders and technology advocates place in new models of digital teaching and learning. Ironically, attacks on the use of technology in K-12 schools and concerns about the skills of the Google Generation contribute greatly to better understanding the competing drivers for educational reform and how to achieve more transformative goals. The successful implementation of digital technology in schools requires deep change and transformative leadership, which involves capturing the hearts and minds of teachers, and wider stakeholders. As Hargreaves and Fullan (1998) remind us:

> Ensuring that technological change will really benefit student learning depends on it being driven by its critics as much as its most ardent advocates (p. 79).

The tension between being critical and offering alternative futures that reimagine formal schooling remains a major challenge. This book helps in this respect, as it does not shy away from confronting a number of issues regarding the integration of technology within both physical and virtual learning environments. While adopting future-focused language it explores many of the challenges facing K-12 schools in authentic real-world settings around the world—ranging from policy development to classroom practice. As such the book avoids the trap of being technology driven by anchoring the discussion in the gap between rhetoric and reality, and does not lose sight of the wider goals of education—that is, developing critical thinkers, critical consumers and critical citizens capable of shaping a better future—for all.

Finally, it is important to acknowledge the hours of work that authors, reviewers and editors have devoted to, and at times slaved over, individual chapters to improve the quality of this book. Writing is essentially about thinking and the hundreds of hours devoted to this book represent a great deal of thinking. It is reassuring that even in today's digital age the words of Dr. Samuel Johnson (1709–1784) ring true:

> What is written without effort is in general read without pleasure.

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Erratum E1

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Chapter 1
Introduction

Tríona Hourigan and Ann Marcus-Quinn

This book is necessary given that digital learning is being strongly promoted at all levels of education at present. Comprising 31 chapters, this publication presents a select number of case studies which reflect and discuss issues regarding the integration of technology within a learning environment, both physical and virtual. As such, this book will guide the adoption, design, development and expectation of future digital teaching and learning projects/programmes in K12 schools. The publication primarily shares case studies and experiences from international digital teaching and learning projects in K12 education. In addition, it outlines advice regarding future school policy and investment in digital teaching and learning projects. The book also provides an expectation on the future capacity and sustainability in digital teaching and learning in K12 schools. Authors from around the word share their experiences and knowledge of adopting digital technology in teaching and learning in K12 schools. It is important to note that all of the featured projects and practices are contemporary in nature, thus providing a snapshot of digital practices in today's schools. Consequently, this makes this book very attractive for all stakeholders including educators and developers.

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Overview of Chapters

Chapter 2, by K. M. Crook (Highgate Wood School, London, UK) and C. K. Crook (School of Education, University of Nottingham, UK) discusses the creation of multimodal opportunities with digital tools. The authors consider the potential of exploiting multimodal communication, or more specifically the often neglected format of narrated-photos or "sound photos" within a distinct educational context. The authors also underline the many challenges related to integrating examples of multimodal digital expression into the established curriculum. These issues are reinforced through observations recorded in an empirical study whereby students were required to create their own multimodal artefacts by using their mobile phones. The main idea behind this intervention was to encourage students to become more aware of the multimodal nature of human communication and in doing so, to consider their own learning via another lens. This chapter also considers the impact of such an approach on educational practice and how digital tools may enhance student awareness of this important form of communication.

Chapter 3, by Helen Boulton (Nottingham Trent University, Nottingham, UK) reports on introducing digital technologies in secondary schools with the aim of both developing literacy and engaging disaffected learners. The research presented here outlines emerging trends from *Literacy and Technology*: *Towards Best Practice*—a project funded by the UK's Teaching Agency, which involved five secondary schools in the East Midlands, UK. In effect, the project introduced digital technologies into two core curriculum subject areas: science and English. The main goal of the initiative was to identify whether digital technologies could intervene and raise the literacy levels of students with special education needs or disabilities and learning needs related to having a second language (EAL). Students experiencing low levels of literacy or identified by their school as being disengaged with learning also participated in this study. Research observations from the project outline its success with raised literacy levels and greater engagement in learning, thus resulting in improved levels of progression.

Chapter 4 considers the transformation of mathematics teaching through digital technologies from a Community of Practice Perspective. Alison Clark Wilson (UCL Knowledge Lab, UCL Institute of Education, London, UK) details work undertaken within the context of a large, multi-year study entitled *Cornerstone Maths*. It is important to note that established research in this area reports a significant underuse of digital technologies in mathematics by learners. In addition, studies also highlight various challenges relating to classroom integration of such technologies by teachers, thus compounding the difficulty of using technology in this specific learning environment. As such, this particular initiative attempts to address the barriers related to low technology integration through the provision of professional development for participating teachers. In this particular context, the experiences of four teachers who engaged with this professional development opportunity is examined from a Wengerian perspective. The research attempts to provide insight regarding the trajectories of the teachers' growth in terms of their subject content knowledge and their emerging pedagogical practice with digital technologies.

Chapter 5, by Tony Hall, Bonnie Thompson Long, Eilís Flanagan, Paul Flynn and Jim Lenaghan (School of Education, National University of Ireland, Galway, Ireland) reviews design-based research (DBR) as intelligent experimentation. This chapter looks towards systematising the conceptualisation, development and evaluation of digital learning in schools. It primarily examines the concepts and principles of DBR within education, and how this specific approach—as a practitioner-oriented, interventionist methodology—can play an important role regarding systematising the design of digital learning in schools. After establishing the present context and reflecting upon the contemporary challenges of technology-enhanced learning in educational contexts, Hall et al. outline and discuss the key features and principles of design-based research methodology. Their chapter takes into consideration the main contributions and indeed limitations of DBR, and how this approach might be introduced and applied—over time—to scale and optimise the impact of design for digital learning in schools.

Moving on to Chap. 6, Charles Crook (School of Education, University of Nottingham, UK) and Natasa Lackovic (Lancaster University, Lancaster, UK) examine how school websites represent digital learning. This chapter endeavours to give us a rare glimpse into the digital culture of primary schools via a comprehensive examination of school websites. Such an approach is highly relevant today, given the increasingly market-oriented and accountability-based environment of schooling. Crook and Lakovic's main intention is to sketch the present landscape of how digital learning is represented in this particular context. Interestingly, one emerging theme from their examination of this digital content was a distinctly low profile detailing the experiences of pupil invention, creativity and connected learning around digital tools. The authors also note the rising prominence of the school App and its potential role in leading future transformations of learning and student experience. The authors reflect upon the promotion (or lack thereof) of digital learning on these school websites and whether or not this is indicative of digital learning in general within these schools.

Chapter 7, stresses the importance of corpus-based resources for L1 teaching, focusing specifically on the case of Slovene. Špela Arhar Holdt, Iztok Kosem (Faculty of Arts, University of Ljubljana, Ljubljana, Slovenia; Institute for Applied Slovene Studies, Trojina, Slovenia) and Polona Gantar (Faculty of Arts, University of Ljubljana, Ljubljana Slovenia) focus on the integration of a corpus for first language (L1) teaching in the higher grades of elementary school and also in secondary school. The researchers provide a description of the Šolar corpus and the Pedagogical Grammar Portal, focusing on the applicative value of the emerging results of their examination of these tools. Furthermore, in this chapter the authors consider the design and implementation of these resources and highlight the main challenges associated with such projects including the advantages and disadvantages of the emerging applied solutions. In addition, the chapter provides the reader with a wider discussion on the usefulness of these results for L1 teaching within K12 educational contexts in general.

Moving on to Chap. 8, Louis Major, Bjoern Haßler and Sara Hennessy, (Faculty of Education, University of Cambridge, Cambridge, UK) highlight the issue of tablet use within schools today. The authors acknowledge the increased popularity that has led to a major uptake of tablets in K-12 learning environments at present. More importantly, this chapter builds on ongoing research by the authors related to the impact of these digital tools on student knowledge and skills as well factors which influence and contribute to successful or unsuccessful uptake of this technology. In this chapter Major et al. provide useful information and helpful advice for educators (including initial teacher educators) and school policy makers who are interested in the educational use and exploitation of tablets. The authors note that, while tablets have significant potential for enhancing learning the most important element in this process remains the teacher, and their individual classroom practice.

Chapter 9, by Ben Murray (National Council for Curriculum and Assessment, Dublin, Ireland) and Sinéad Tuohy (Junior Cycle for Teachers, Monaghan, Ireland) details the participation of Ireland as one of seven European countries participating in the EUfolio Classroom ePortfolios project. This was a 2-year project, from May 2013 to May 2015, which was funded by the European Commission under the framework of the Lifelong Learning Programme. The chapter focuses primarily on the experiences of the Irish pilot, and in turn highlights specific examples of where ePortfolios were used to encourage a collaborative approach to assessment and learning. In this context, the authors note how the various interactions between participating teachers and students actually opened up the learning process, thus allowing the establishment of a more supportive culture which enabled formative practices in the classroom to emerge and develop.

In Chap. 10, Christina Preston (MirandaNet Fellowship; De Montfort University, Leicester, UK) and Sarah Younie (MirandaNet Fellowship; De Montfort University) use the topic of mobile devices or tablets in teaching and learning to show how professionals engaged in a community of practice such as MirandaNet can learn and exchange ideas about innovation in school environments. As an example of how a community of practice can work in today's world, Preston and Younie demonstrate how a member might learn about the role of tablets in systemic change in relation to social networking, online practitioner debates, through online members' publications, conferences and through various action research projects. The authors note that these observations are indeed highly useful principles which professional community could adapt and apply to any curriculum theme or leadership topic. The authors highlight the fact that such an approach is possible today due to increased access to technologies which help to sustain a community group unable to meet face to face on a regular basis.

In Chap. 11, Stylianos Sergis (Department of Digital Systems, University of Piraeus, Greece and Information Technology Institute, Centre for Research and Technology, Hellas, Greece), Effrosyni Papageorgiou (Department of Digital Systems, University of Piraeus, Greece), Panagiotis Zervas (Department of Digital Systems, University of Piraeus, Greece and Information Technology Institute, Centre for Research and Technology, Hellas, Greece), Demetrios G. Sampson (School of Education, Curtin University, Australia and Information Technology Institute, Centre for Research and Technology, Hellas, Greece) and Lina Pelliccione (School of Education, Curtin University, Australia and Information Technology Institute, Centre for Research and Technology, Hellas, Greece) present an evaluation of lesson plan authoring tools based on an educational design representation model for lesson plans. The authors note that within online teaching communities, lesson plans (LPs) are commonly used to capture and disseminate teaching practice. However, they argue that there are no commonly accepted and appropriately designed models for representing LPs. This particular shortcoming is also identified in the existing LP authoring tools. Consequently, to address this pertinent issue, the authors propose an educational *Design-driven LP Representation Metadata Model*. This chapter critically evaluates of a set of widely used LP authoring tools. The authors' findings in their evaluation underline various shortcomings in this area and as such they propose a number of guidelines with regard to future implementations of LP authoring tools.

Chapter 12 focuses on the implementation of teaching model templates for supporting flipped classroom-enhanced STEM Education in Moodle. In this chapter, Stylianos Sergis (Department of Digital Systems, University of Piraeus, Greece and Information Technology Institute, Centre for Research and Technology, Hellas, Greece), Panagiotis Vlachopoulos (Department of Digital Systems, University of Piraeus, Greece), Demetrios G. Sampson (School of Education, Curtin University, Australia and Information Technology Institute, Centre for Research and Technology, Hellas, Greece) and Lina Pelliccione (School of Education, Curtin University, Australia and Information Technology Institute, Centre for Research and Technology, Hellas, Greece) introduce a set of flipped classroom-enhanced teaching model templates which focus on two widely used STEM-appropriate teaching models: namely, the inquiry- and problem-based teaching models. This chapter presents the implementations of the particular teaching templates in Moodle—a widely used open source Learning Management System. According to the authors, the primary added bonus associated with the proposed adaptable Moodle templates is to offer support to (novice) STEM teachers. Such support would be helpful to teachers in terms of their educational design (through their exploitation of the proposed templates), and also in the delivery of this content in their individual lessons or teaching scenarios.

Chapter 13, by Michael J. Timms (Australian Council for Educational Research, Camberwell, VIC, Australia) presents an assessment of online learning. Timms notes how one of the challenges for the teacher in an online learning environment is to maintain awareness of each individual learner's progress towards the instructional objectives. As widely acknowledged, within a traditional a face-to-face classroom environment, simple observations by the teacher of student body language can easily communication difficulties or lack of understanding to the teacher. However, online learning typically removes some of these channels of information that are available in a conventional classroom setting. As a result, this leads to the teachers relying more on channels such as assessment of learning. In order to address this issue, Timms explores the various kinds of assessment that are possible in an online learning environment and how might these may be integrated into the instructional process in order to enrich both teaching and learning.

Chapter 14 examines digital literacies in a Chinese secondary school. Xiaofan He and David Wray (Centre for Education Studies, University of Warwick, Coventry, UK) note that many studies relating to literacy practices of adolescents in technological environments have primarily focused on Western countries. Many educational practitioners in China maintain that technology has the potential to introduce a “new direction” into the Chinese education system—one which is often characterised by rote learning and teaching to the test. Their chapter provides us with an important insight into the development of digital literacies within a Chinese post-primary school environment. The empirical study reported in this chapter centres upon one secondary school with digitised classes in Xiamen, China. The outcomes of this case study are used to suggest some emerging key features relating to the literacy practices of these students within a digitised learning environment. The authors provide useful and insightful comparisons between these emerging “Chinese” features and what is established from research into similar situations in Western educational settings.

Chapter 15 examines the role of digital technologies in collaborative open space learning programmes developed at Northern Beaches Christian School, Sydney, Australia. Stephen Mark Collis (Sydney Centre for Innovation in Learning, Northern Beaches Christian School, Australia) firstly outlines the role of an in-house innovation incubator in nurturing a school philosophy that values emergent interactivity. He then justifies the implementation of this philosophy by applying Self-Determination Theory. Collis goes on to describe a number of open space learning designs and makes reference to the practical use of digital technologies in this context. Collis also proposes an ecological design language that “interprets structures in physical, virtual, and cultural space by their ability to facilitate emergent, unscripted interactions between people, their environment, and information”. This chapter highlights the “paradoxical importance of linearity, constraint, and expert teaching in learning designs that set the scene for emergence to occur”.

In Chap. 16, Gregory Powell (College of Arts, Social Sciences and Commerce, School of Education, La Trobe University, Melbourne, VIC, Australia) introduces the use of blogs as digital technology reflective instruments for pre service teachers. In this particular chapter, Powell describes blogging technologies which aim to build knowledge, promote independence, as well as engaged and active learning in order to tailor the learning to pre-service teachers for the twenty-first century. According to Powell, it is through blogging that pre-service teachers experience a form of authentic learning which, as we are all aware, is critical to teaching and learning in a modern-day setting. Powell goes on to underline and demonstrate a number of educational understandings as pre-service teachers collaborate and create individual and indeed authentic online and offline learning experiences through their use of these tools.

In Chap. 17, Paul W. Bennett (Saint Mary’s University, Halifax, NS, Canada) assesses digital learning in Canadian K-12 Schools and reviews critical issues, policy and practice. He notes how digital learning is increasingly becoming more popular in Canada and how it is now impacting upon education policy in most of the nation’s ten provinces and three territories. Interestingly, as a national education department does not currently exist, the promotion of 21st century skills, technology and learning becomes the responsibility of provincial and territorial education authorities with varying degrees of commitment to this issue. Bennett points out in this chapter that even though national advocacy groups do have some degree of influence over provincial ministers of education, the integration of 21st century learning is still not evenly distributed. This is particularly the case outside of the recognised eLearning leaders among provinces such as: Ontario, British Columbia and Alberta. Bennett argues that despite the great potential for the development of online learning and virtual education, the free market remains regulated and private providers do not play a prominent role. In fact, as Bennett outlines, provincial or school district authorities encourage a more “growth-management approach” where both online and blended learning are considered the next stage of effective technology exploitation and integration.

Chapter 18 investigates the idea of the flipped classroom with the main focus on how to facilitate personalised learning through the help of digital tools. In this chapter, Maurice de Hond (Chairman of the Foundation Education for a New Era, Amsterdam, The Netherlands and http://www.stevejobsschool.world) and Tijl Rood (Director of De Verwondering, School, Amsterdam, The Netherlands and http://www.stevejobsschool.world), explore how information technology can play a pivotal role in establishing a culture of individualised learning in schools. The authors reflect on both the importance of reforming the traditional classroom environment and on recent difficulties encountered by educators in addressing this issues. Consequently, de Hond and Rood emphasise that by embracing and integrating digital tools, schools are in a position to evolve from a traditional one-size-fits-all approach to facilitating more personalised learning experiences for all individuals. Both authors argue that the organisational and the educational aspects of schools can easily be transformed if schools themselves are open to reconsidering their educational goals.

Moving on to Chap. 19, Elizabeth Hartnell-Young, (Australian Council for Educational Research; The University of Melbourne, VIC, Australia) outlines current education policy in Australia, referring specifically to technology provision and an increasingly national approach to teaching, assessment and curriculum. The author highlights the importance of conducting online assessment with a growth mindset, whereby teachers and educators facilitate and enable their students to demonstrate growth over a specific period of time. This is seen as a necessary component in meeting the first Professional Standard. Her work outlines examples from a Learning Assessment System to support this initiative and the role which technology plays in this context. The chapter provides and analyses data from schools working with researchers, government and industry in order to establish such assessment tools that meet their individual needs. The author emphasises the need for local and global collaboration in order to meet the demands of this complex task.

Chapter 20, by Dovi Weiss (Kibbutzim College, Tel Aviv, Israel), introduces a case study which investigates one to one computing integrated within a mathematics class. Weiss begins by highlighting one to one computing as an important educational reform which facilitates ubiquitous access to a digital devices by both teachers and students in the classroom. Weiss considers the largely positive results from recent research studies which have highlighted gains in areas such as student engagement, pedagogy and availability to digital content resources. However, despite these encouraging reports, Weiss points out the lack of curricular resources and aligned digital content made available to teachers and students. He discusses the development of a digital teaching platform which was designed to support the Common Core ELA and Mathematics curriculum. As such, this chapter describes the effects of integrating such a platform into a mathematics classroom in a school in Brooklyn, US during the 2011 school year.

Chapter 21, by Gregory R. Moore and Valerie J. Shute (Florida State University, Tallahassee, Florida, USA) looks at improving learning through a stealth assessment of conscientiousness. In this chapter, the authors describe the importance of assessing and developing conscientiousness in students and how they are approaching this challenge. Moore and Shute discuss the inherent benefits conscientiousness has for learning and then move on to highlight the process which they are using to establish a valid stealth assessment of conscientiousness. The authors consequently consider the current state of this work and move on to highlight a number of areas for future research into this important theme. The scope of this chapter addresses the strengths and limitations of using stealth assessment to measure non-cognitive competencies. Some recommendations are suggested in order to help others use this approach. The authors' main aims are to emphasise both the importance and complexity of conscientiousness measurement in educational environments, and a general process for reflecting upon and designing assessments for non-cognitive competencies.

Chapter 22, by Saleh Alresheed (Bedfordshire University, London, UK) offers insight into integrating computer-assisted language learning (CALL) in Saudi schools. Presently, in Saudi Arabia, the government is aiming to provide most educational institutions with computers and networking for integrating CALL into classrooms. However, the author notes that integrating digital technologies into typical language learning classrooms is not readily accepted, particularly where the teaching of both English language and information and communication technologies (ICT) is subject to religious and cultural constraints. The chapter introduces a case study approach using mixed methods in order to interview and observe a sample of teachers and school inspectors in urban and rural secondary schools. The emerging findings from this study point to recommending a model to deal with and address the covert and overt issues identified. It would also be hoped that this model may provide systematic support for integrating CALL into Saudi Arabian English language classrooms in the future.

Chapter 23, by Gregory Powell (College of Arts, Social Sciences and Commerce, School of Education, La Trobe University, Melbourne, VIC, Australia) provides us with insight into challenge-based learning and sandbox experiences that integrate digital technologies for pre service teachers at a higher education institution in Victoria, Australia. In this chapter, Powell introduces and describes a range of digital technologies that aim to enhance teacher knowledge, promote active learning, autonomy, and personalise learning for individuals in the twenty-first century. In this chapter, Powell describes how through challenge-based learning and the provision of Sandbox experiences pre-service teachers are able to experience authentic learning inquiries that are pivotal to modern teaching and learning in today's world. The participants in the study play, create, build, collaborate and reflect on their learning and as a result demonstrate their understanding of this through the use of digital technologies. Powell aims to emphasise how this approach enhances and reinforces pre-service teacher education experiences.

In Chap. 24, Keith S. Taber (Faculty of Education, Science Education Centre, University of Cambridge, Cambridge, UK) explores the role of new educational technology in teaching and learning by offering a constructivist perspective on digital learning. Taber outlines how constructivism draws upon research into the nature of learning to inform pedagogy. According to the author, from a constructivist standpoint, we can view educational technologies as potential tools for enacting curriculum through particular pedagogical approaches. Thus, new technologies make an important contribution to the teacher by offering alternative ways to facilitate learning. The author highlights that while digital technologies offer many new possibilities for teachers, they should always be used as part of a principled pedagogical approach rather than seen as ends in their own right. Taber's work considers the key principles of constructivist thinking with regard to learning, and offers a number of informative examples which outline how digital technologies can potentially support school teachers in adopting a constructivist perspective to inform and enhance their classroom work.

In Chap. 25, Temtim Assefa (Department of Information Science, Addis Ababa University, Addis Ababa, Ethiopia) gives an account of implementing educational technology in Ethiopian high schools through instructional Plasma TV. The study reveals a number of benefits reported by teachers and students using this technology. For example, the author notes how its multimedia content presentation is useful for maintaining student attention and also helps to simplify complex concepts with visual demonstration. However, the author identifies a number of student, teacher and technical related problems. This includes the fast delivery of content in advanced English which is problematic for some students. Teachers feel that they cannot use their skills and knowledge to assist their students. In addition, technical problems interrupt the normal flow of the teaching learning process. This chapter provides us with valuable insight into the Ethiopian experience of technology integration and encourages us to consider the challenges facing developing countries in this regard.

In Chap. 26, Megan Poore (Australian National University, Canberra, ACT, Australia) discusses the issue of managing risk in the school social media environment. The author notes how the use of social media in the classroom has become an important topic in recent years. While much of the established research addresses young people's online behaviour and its associated dangers, there is less discussion on the need to manage the risks of digital technology use within the school environment. This chapter provides an overview of some of these aforementioned risks The author focuses on what teachers need to do in order to address this issue and also covers some of the critical elements which need to be considered. In this chapter, Poore discusses the importance of professional development to address this question as well as the need to put into place proper support structures and suitable risk management procedures. Poore also underlines the need for an informed policy environment in schools, particularly if teachers and students wish to benefit from exploiting social media for teaching and learning purposes.

Chapter 27, by Anna Dabrowski and Jason M. Lodge (The University of Melbourne, Parkville, VIC, Australia) looks at the issue of pedagogy, practice, and the allure of open online courses, noting a number of implications for schools. As access to education continues to flourish in the online environment, Dabrowski and Lodge provide us with an overview of current and emergent applications of online learning. The authors focus on the implications regarding these developments for the school sector. The chapter outlines in particular the recent rapid expansion of massive open online courses (MOOCs) and considers both the advantages and potential disadvantages of MOOCs within school settings. The authors debate as to whether or not online learning is suitable as a tool for teaching and learning when used by a cohort of high school students. In a time where some nations are signalling a movement towards acceptance of such courses in school environments, the authors outline implications for policies and practices of schools, and the type quality of learning which students would receive.

Chapter 28, by Ann Marcus-Quinn (University of Limerick, Limerick, Ireland) and Tríona Hourigan (Department of Education and Skills, Ireland) emphasises the potential of OERs for K-12 Schools. The authors report that while there is a growing body of work advocating the use of Open Educational Resources (OERs) to enhance teaching and learning there are still barriers preventing teachers from integrating such resources into the classroom. According to the authors, one possible means of overcoming these issues is to raise awareness of the potential of OERs by either placing an emphasis on them during accredited Initial Teacher Education programmes or through continuing professional development programmes aimed at existing teachers. This chapter goes on to discuss why it is necessary to put a policy in place to actively advocate and promote the use of OERs at second level.

Chapter 29, by Anne Heintz (Michigan State University, East Lansing, MI, USA), Michelle Schira Hagerman (University of Ottawa, Ottawa, ON, Canada), Liz Owens Boltz (Michigan State University, East Lansing, MI, USA) and Leigh Graves Wolf (Michigan State University, East Lansing, MI, USA) documents teacher awarenesses in relation to blended instruction practices. In this chapter the researchers interview four early career teachers who have adopted blended instructional practices for their classrooms. These particular teachers established their own individual blended classroom environments, remaining mindful of systems-based thinking that reflected awareness of self, students, content, pedagogy and interaction. Through in-depth discussions with the participating teachers, the authors highlight the emerging dynamic systems synonymous with blended learning. Emphasis is placed on the drive which all teachers had to innovate with renewed focus on the techniques used to achieve these particular educational goals.

Chapter 30 proves an appraisal of professional communities of practice and reflects on ways in which to develop these reflective spaces effectively. Wouter Vollenbroek, Joachim Wetterling and Sjoerd de Vries (University of Twente, Enschede, The Netherlands) reflect on the Dutch education system and on how it is gradually evolving from a standardised curriculum to a more personalised approach to education. As a result, Dutch teachers are becoming increasingly aware of the continuous need for professional development and innovation in order to address the learning needs of students in the twenty-first century. The chapter reports on a professional community of practice, namely Education21 (http://www.onderwijs21.nl), which has been established to encourage cooperation between education stakeholders in order to address the needs of schools in the twenty-first century. The network behind Education21 consists mainly of individuals working in primary schools, secondary schools, teacher education institutes as well as education professionals who recognise the importance of continuous professional development. In this chapter, the authors describe their approach, give specific examples emerging from the community and describe various challenges which have emerged.

Finally, in Chap. 31, José Lagarto (Centre for Communication and Culture, Universidade Católica Portuguesa, Lisboa, Portugal), Carla Ganito (Centre for Communication and Culture, Universidade Católica Portuguesa, Lisboa, Portugal) and Hermínia Marques (Centre for Studies in Human Development CEDH, Universidade Católica Portuguesa, Lisboa, Portugal) report on the preliminary results regarding a three year Portuguese project on digital textbooks made available to students via tablet technology. The focus of this chapter looks primarily on emerging data concerned with student behaviour and attitudes surrounding the integration of these tools into the particular learning environment. Interestingly, while emerging results highlight an increase of motivation amongst the students, this sense of motivation does not correspond with grade improvement. In their analysis, the authors discuss the importance of a paradigm shift within the teaching process itself and on the need to focus on skill acquisition in order to help students to integrate tablets adequately into their studies. The authors conclude by offering a number of helpful recommendations to allow schools, parents and young people to address this ever-complex challenge in both teaching and learning contexts.

Conclusion

Overall, this book aims to give a comprehensive overview of digital learning as it is currently practised worldwide. It is our intention that this publication may appeal to both those wishing to explore the possibilities afforded by digital learning and more established practitioners. The majority of these chapters are drawn from authentic real-world experiences and therefore are legitimate examples of good practice. When compiling the submissions for this publication it was imperative to capture case studies from around the world and not to focus on maintaining the status quo. As such, this type of compilation pushes us to acknowledge the diversity of experience associated with all stages of digital learning and integration across the spectrum of ICT in education. It has certainly been insightful to engage with the different voices from both the public and private sectors. Furthermore, it is important to embrace the potentially disruptive nature of technology while not letting it dictate the landscape of the learning environment. As the technology moves so quickly we must both move with it and yet remain critically reflective of ways of effectively integrating it into elearning. We cannot get complacent, nor can we become slaves.

Chapter 2
Multimodal Opportunities with Digital Tools: The Example of Narrated Photographs

K.M. Crook and C.K. Crook

Abstract This chapter explores recent encouragement to cultivate in students a sensitivity towards the "multimodal" nature of human communication. We consider what this means for educational practice and, in particular, how such an imperative might be addressed with digital tools. In particular we report a field study of secondary school students creating narrated photographs to characterise their local community and to construct sequences in the style of graphic novels. Although students were well engaged by this activity, many were hesitant in using their voice expressively. This variation in voicing confidence reminds us that education creates few opportunities for students to think about their speech in instrumental terms. Yet, we did see in some students a willingness and ability to do this. Adapting speech-for-purpose is a fundamental social skill. Thus, there is a need to take oracy more seriously and to see digital tools as one opening to do so in a practical way. Likewise, this project revealed disparities in students' confidence with visual expression: differences that implied a lack of experience in seeing the semiotic potential of the image. These observations suggest that educators should help students read (and compose) in these modalities as carefully as they help students to acquire more familiar text literacy.

Keywords Creation • Multimodal opportunities • Digital tools • Multimodal communication • Narrated photos • Multimodal digital expression • Curriculum • Mobile phones • Lens • Educational practice • Digital tools • Student awareness

This chapter explores recent encouragement to cultivate in students a sensitivity towards the "multimodal" nature of human communication. We consider what this means for educational practice and, in particular, how such an imperative might be addressed with digital tools. In discussing these issues, a neglected format for multimodal digital expression will be introduced: namely, narrated images or "sound

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photos". Observations on multimodal expression are then offered as they were prompted from an intervention requiring students to create such artefacts with digital tools. Taken together, these observations highlight both the potential of extending multimodality more firmly into the curriculum but also the challenges that can arise from doing so.

The chapter starts with an outline of what is entailed in the concept of "multimodality". It then considers how digital tools relate to this notion, and the format of a narrated photograph is introduced. A practical exercise within the realm of mobile learning is described and its implications for addressing issues of visual literacy and oracy are discussed.

The Multimodal Nature of Human Communication

Kress and colleagues have famously declared that "… the English classroom is about meaning" (Kress et al., 2005, p. 3) and they illustrate how the multiple resources available for making meaning transcend speech and writing. They even suggest that the word "language" is no longer satisfactory within communication research, given the range of those resources beyond words that have meaning-making potential.

In the last 10–15 years, "modes" has become an increasingly popular term for such varied resources (Jewitt & Kress, 2003; Kress, 2005; Kress et al., 2005). Defined as a "socially shaped and culturally given semiotic resource for making meaning", a mode is any single resource that has been selected while communicating within our social world (Kress, 2010, p. 79). Speech and writing are obvious hosts for modes, but gesture, moving image, soundtrack and 3D objects are just as valid resources for making meaning (Kress, 2010, p. 79). Moreover, Kress would argue that in many forms of communication the coming together of different modal solutions is necessary, because different modes offer different potentials and affordances. For example, grammar, syntax, font, size and colour are some of the resources that shape the potential of a piece of writing. Meanwhile, an image might deploy size, colour, line and space. The act of bringing together more than one mode to communicate has been termed "multimodality".

A useful classroom example of multimodality in action is the process of oral storytelling. Grishakova and Ryan (2010) identify "face-to-face communication: sound, gestures and facial expression" (2010, p. 4) as highly functional modes in the act of communicating stories, reminding us that acts of communication are often far more multimodal than we might suppose. In the digital domain, websites and social networking facilitate communication through a plethora of modes, drawing upon written text, image, video, sound and speech (Spalter & van Dam, 2008).

Such contexts demand "multimodal analysis". This has been described by Jewitt as an approach towards "… representation, communication and interaction as something more than language" (2009, p. 1). Even when language is the seemingly primary mode of communication, it is often "… inseparably related to other modes of meaning" (Cope & Kalantzis, 2000, p. 38). Analysing the practice of communication requires appreciation of every resource used in this process (Jewitt & Kress, 2003, p. 2). Indeed Kress, a pioneer of multimodality, argues that interacting with the world using more than one resource, or mode is "… the normal state of human communication" (2010, p. 1) and that modes rarely occur alone. Thus, to focus solely on the most commonly acknowledged modes of speech and writing is "confused and contradictory" (Jewitt & Kress, 2003, p. 2).

Although analysts urge that "… all modes of communication drawn on in the making of meaning are given equally serious attention" (Stein, 2008, p. 1), that need not suggest that all modes are equally useful all of the time. Different modes carry different affordances and different potentials (Jewitt & Kress, 2003, p. 3). Indeed limiting a person's choice of resources, or modes, is thereby limiting their communication potential.

A multimodal approach to analysis of communication requires a shift in theorising. While the analysis of written text is grounded in theories of linguistics, multimodal analysis draws from social semiotics, a form of enquiry that considers the meaning potential of different resources, within a specific social context (Van Leeuwen, 2005, p. 4). The key to this theoretical approach is that it places social actors "… at the centre of meaning making" (Stein, 2008, p. 2) and considers communication as "… a product of how people work with, use and transform the semiotic resources available to them in specific moments in history" (Stein, 2008, p. 2). In an educational context, viewing communication and composition through this theoretical lens identifies a need to consider fresh pedagogical approaches to teaching and learning, approaches that are context-sensitive. To be used effectively, the affordances of different modes and their communication potential must be better understood by learners—and educators must recognise their role in this (Metros, 2008). In particular, students need to be aware of the shifting and fluid nature of modes, as well as recognising those with well-established significance. Thus, the following section will address the arguments for cultivating multimodal pedagogies in classroom teaching.

Multimodal Pedagogies

In school, written language is a primary form of communication and representation. However, many argue that such a focus has come at the expense of other resources for making meaning (Cope & Kalantzis, 2006; Stein, 2008; Wulf, 2013). Of course, without teaching children the written mode of communication, their power as actors within society would be limited. However, an almost exclusive concern in schools with this particular mode of *writing* creates obstacles for certain students—whose strengths may not lie there. Yet disparities in people's communication access is not the only reason that the focus on written language is sometimes challenged. Kress and Van Leeuwen (1996) cite shifting cultural practices. They propose that "language is moving from its former unchallenged role as *the* medium of communication to a role as *one* communication" (1996, p. 38).

Practitioners of multimodal pedagogies recognise that different modes offer different affordances. Furthermore, it is acknowledged that the choice of mode is based on the sign-maker's interests, as well as what happens to be available to them (Jewitt, 2006; Jewitt & Kress, 2003; Stein, 2008). So if written language is prioritised such that it is the *only* available resource on offer, then educators are limiting the sign-maker's resources and potentially denying their interests.

Stein (2008) argues that in order to create a democratic and versatile classroom, educators must encourage expression through a variety of modes, building on the vast range of resources that students bring (Stein, 2008, p. 3). Kress and van Leeuwen (2001) suggest that for young people to compose in a way that reflects contemporary society's definition of a text, they must acquire knowledge of media, art, technology, digitalisation, colour etc.: semiotic modes that reflect society's prevailing resources. In sum, for educators to truly prepare their students for active involvement in their sociocultural environments, schools should move away from the idea that speech and writing are the *only* "… essential ingredients in the life of social man" (Halliday, 1978, p. 16).

Research into multimodal composition in schools demonstrates positive outcomes. For example, Cercone (2012) worked with a teacher and his class of 12th grade English Arts students, investigating the impact of a multimodal composition project. Students produced personal writing, based on songs that were meaningful to them and, from this writing, developed music videos. This encouraged students to draw from their own personal experience, participate in collaborative learning, and produce purposeful texts. Cercone argues that whilst this project offered students the chance to draw from new classroom resources and their outside literacies, it also served to engage students "… more deeply as readers and writers than their previous traditional English courses" (2012, p. 76). One reason being that it challenged them to draft and redraft, working in multiple modes and through a variety of media.

There have been numerous other studies of students' multimodal composition that reveal positive influences on reading and writing (e.g. Bailey, 2009; Blondell & Miller, 2012; Kajder, 2004; Mills, 2010). Furthermore, other research shows how multimodal composition also promotes opportunities for students to develop their social identities (e.g. Alvermann, 2001; Vasudevan et al., 2010; Wissman, 2008). These outcomes imply that multimodal composing practices could contribute significantly to young people's expressive and representational development.

From the perspective being developed here, students should be allowed to engage not just in single acts of multimodal composition but in multiple acts of composition, and deploying multiple modalities. Multimodality should become a comfortable way of thinking and communicating. Arguably, for students to fully participate in contemporary society, multimodality must become embedded in their learning. Acts of multimodal composition thereby contribute to effective *literacy* development.

Yet in Education research, the reach of this term "literacy" has always been a contested matter. Many commentators therefore retreat to "new literacies", a phrase which signals the ever changing malleability of the concept. However, even this is up for debate. To some, new literacies are new *social practices* (Street, 1995), others refer to them as the strategies and approaches to new tools of communication

(Castek, 2008; Coiro, 2003; Leu, Kinzer, Coiro, & Cammack, 2004) while Gee (1996) sees them in relation to new "Discourses". Moreover, others have opted to develop still further terminologies to locate the "new literacies". These include "metamedia literacy" (Lemke, 1998) and "multiliteracies" (Cazden, Cope, Fairclough, Gee et al., 1996; Cope & Kalantzis, 2000; Snyder, 2002). Lankshear and Knobel (2007) propose a synthesis in which new literacies are "… socially recognised ways of generating, communicating and negotiating meaningful content through the medium of encoded texts within contexts of participation in Discourses (or, as members of Discourses)" (2007, p. 64).

It may be helpful to invoke the notion of a "literacy" to capture resourceful and effective deployment of some *family* of communication modes. However, untangling this higher level concept is not a priority for the present chapter. Higher order conceptions that are of greater concern here are those that arise in the exercise and development of original *multi*modal constructions. We turn to this in the next section: considering particular forms of the multimodal that might arise in classroom activity.

Formats for Multimodal Exploration

In discussing the enrichment of communication experience, most authors cited so far readily accept that digital tools are increasingly important. However, the present discussion is highlighting a rather particular form of communication and a rather more particular interest in digital tools. That interest is one of identifying how digitally mediated practices can offer students opportunities for constructing communication designs that are *multimodal* in nature. This means that we are interested here in how digital tools allow discrete communication modes to be creatively *interwoven*.

As has already been stressed, everyday communication is saturated with multimodality and so we can assume that most young people enjoy a degree of competence in their engagement with it. However, receptive confidence is one thing, productive confidence is another. Our comments above have urged that educational practice embraces multimodality—but as a *productive* achievement, not just a receptive one. This gives rise to a concern about current practice. One part of this concern is widely shared. Namely, the idea that current practice could do more to encourage in students a rich repertoire of expressive modes: resources that prepare them for versatile communication. Where there is effort towards this goal it tends to be concentrated in the domain of written language. This is proper and unsurprising but it is also an effort that could be widened to other modalities.

However, a deeper concern we have here is that educational practice should also consider a form of versatility that is realised within effective *multi*modal expression. That is, competence in *simultaneously* recruiting communication modes that complement each other: reflecting on the possible dynamics that this interweaving allows. Established research into multimodal compositional practice suggests that combining modes is something that both strengthens the existing meaning of a text, whilst forming new meanings beyond the capabilities of a single mode (e.g. Hull &

Nelson, 2005; Kress, 2003). Hull and Nelson (2005) propose that "… a multimodal text can create a different system of signification, one that transcends the collective contribution of its constituent parts" (2005, p. 225). Vasudevan et al.'s (2010) research on developing students' "literate identities" through multimodal composition concluded that their student participants' authorial voices "grew in volume and depth" (2010, p. 462) when layering different modes to create texts.

The two prominent modalities of text and image readily complement each other and are the natural candidates for any such ventures in expressive development. Text and image composition is a well-developed multimodal format and its potentials are widely acknowledged within educational research. Graphic novels are one form of such composition. For example, they can support EAL students with language and communication skills development (e.g. Chun, 2009; Danzak, 2011; Jewell, 2009), they can be used to explore personal identity (e.g. Cary, 2004; De Fina, 2006; Hughes, King, Perkins, & Fuke, 2011; Sfard & Prusak, 2005), and they can engage students in multiliteracy development (e.g. Schwartz & Rubinstein-Ávila, 2006; Seglem & Witte, 2009; Wilhelm, 2004). However, writing is not the only way in which we know language. We also know it through speech.

Voice is one of the most commonly utilised modes of expression. Evidently it is most encountered in the everyday flow of conversation. But vocal expression is becoming more part of performance in the online world. Websites have made it possible to compose and upload speech as easily as text. Moreover, network communication tools and online participative gaming sites make live speech interaction a natural and far-reaching communication possibility. LaBelle (2008) notes how voice offers a strongly personalised communication practice: "The voice comes to us as an expressive signal announcing the presence of a body and an individual" (LaBelle, 2008, p. 149). He suggests that when we listen to a voice we automatically attach it to a person in a way that does not seem to occur with writing. Likewise, Neumark (2010) suggests that a performative human voice is able to call another into "… an intimate relationship … through vocal qualities and vocal performance" (Neumark, 2010, p. 96), again signalling something deeply personal about the spoken word.

Yet the importance of voice is often found to be neglected in educational contexts. The UK standards authority for schools, "Ofsted", sees speech for communication as an area requiring serious attention. Their concern is expressed in "Moving English Forward" (Ofsted, 2012), a report of English inspections in 2010–2011. They note that: "Previous subject inspections have identified a lack of emphasis on explicit, planned teaching of speaking and listening. This remains the case." (2012, p. 48).

Nevertheless, outside of school it is very common for visual modes of representation to be encountered in conjunction with speech—most obviously in film and television. However, a method of multimodal meaning making that is far less familiar is the amalgamation of speech and *still image*. Despite the ubiquity of narrated *moving* images, the idea of a discrete artefact in the form of an isolated narrated image is a rarity. Although it shares similarities with film, a "sound-photo" approach to meaning-making might encourage students to focus solely on the affordances of image and speech, promising new insights on multimodal composition.

Only Frohlich has been really active in pursuit of the sound and image composition, although his work lies outside of formal education. His "Audiophotography" (Frohlich & Tallyn, 1999) suggests that "sounds of the moment" can add meaning and impact to photographic images.[1] Closer to education is Frolich's recent work on digital storytelling using mobile phones in poor, rural Indian communities: the StoryBank Project (Frohlich, 2007). His findings document increased involvement in the creation of content, as well as increased culturally based knowledge-building activity (Frohlich et al., 2009). Moreover, the removal of barriers to composition tools and to written literacy gave many people within the community a "… new voice by which to express themselves and their place in the world" (Frohlich et al., 2009, p. 34).

However, if multimodality of this kind is to be constructed by students—what are the tools that may support their ambitions? We turn to this question next.

Multimodal Digital Tools

Another member of the "literacy family" to acknowledge is "digital literacy". The earlier term "computer literacy" was primarily concerned with an ability to operate the technology, often with an emphasis on coding (Molnar, 1978). Currently, it is more natural to view technology as tools that facilitate "… social and cultural processes, rather than primarily technical ones" (Buckingham, 2010, p. viii). Accordingly, commentators such as Rheingold (2008) highlight a corresponding shift from print culture to more participatory media, a shift which could "shape the cognitive and social environments in which twenty-first century life will take place" (2008, p. 99). Schools and educators are thereby urged to recognise their responsibility as facilitators in the development of young people's digital literacy, in order to empower them as active participants in a changing society.

Yet for some time, research observers have warned that the culture of the classroom is becoming increasingly removed from young people's experiences outside of school (Levin, Arafeh, Lenhart, & Rainie, 2002), particularly in relation to the use of digital technology. Therefore, in a society increasingly fuelled by digital communication, it seems that schools should seek to embrace these new practices in order to integrate "… what [students] know and do out of school with what they do in school" (Thompson, 2008, p. 145). In doing this, educators can draw on students' knowledge and personal interest in digital communication tools.

Personal and mobile digital platforms such as tablets and smartphones readily facilitate constructing the kind of layered speech and image composition that has been proposed above. Developing communication confidence in this way is timely. Many commentators declare that the versatility of smartphones and tablets could redefine the way educators approach their craft, enabling more one-to-one support, learning in context and the seamless integration of different learning spaces: formal and informal, shared and personal (Philip & Garcia, 2013). So, Seow and Looi

[1] Chris Marker's film "La Jetee" is a rare (but admired) cinematic example.

(2009) echo these points, advocating a fresh "… continuity of the learning experience" (So et al., 2009, p. 368) made possible by the mobility of these digital tools.

Moreover, multimodal composition is an obvious affordance of this personal toolkit, and Kress (2003) argues that it is not just made "possible" using mobile technology, but also "… easy, usual, 'natural' …" (2003, p. 5).

In the remainder of this chapter we outline how familiar digital tools (personal, networked and mobile) might be deployed from the classroom to support multimodal exploration. The narrated photograph was chosen as the multimodal artefact for the case study that follows. As acknowledged above, this format is relatively unusual. However, it is this very unfamiliarity that made it attractive. By working with a design that was easily understood and yet novel, it was expected that student attention to issues of effective communication would be more finely focussed and that the difficult topic of modalities might be more comfortably introduced. The case study involved secondary school students constructing these sound photos around two accessible themes. We reflect on their work and note how they responded to the exercise through their reactions as shared in focus group discussions.

The Narrated Photograph: Case Study Procedure

The work took place in an inner-city London secondary school. It was a mixed comprehensive establishment, educating around 1200 students from the age of 11–18, and situated in a multicultural community. The participants were volunteers from a group of 26 Year 7 English Language students of mixed ability. The project was conducted over a period of approximately 14 weeks. These students were chosen because the class had a good track record for homework completion and the project relied heavily on students composing outside of the classroom. Full details of procedure are in Crook (2015). It was apparent that although the students were in many ways adept with mobile technology, their "digital literacy", in the modern sense, was limited. "Logging on", setting up accounts and passwords, instant messaging and social networking were evidently second nature. However, acts such as connecting with Wi-Fi, diagnosing technical issues and responding to error messages sat far less comfortably.

To begin, the class were invited to evaluate a collection of neighbourhood sound-photos made by an adult. They were then given the title of their own topic: namely, "Our Local Area". The students were told that they were going to produce a gallery of sound-photos, sharing points of neighbourhood interest. It was stressed that these items could be anything from shops, to monuments, to the students' favourite outside spaces. The exercise was organised in four groups of four students. Most students used their own smartphones—which were mainly Android, a small number used iOS devices, and three android phones were lent by the teacher. The topic was chosen for several reasons. First, it was broad enough to offer the students flexibility in their interpretations—encouraging students to take ownership over their composition choices, rather than limit their options with a rigid and narrow framework.

Second, it was designed to be logistically sympathetic, encouraging students to focus on resources readily available to them. Finally, it aimed to provoke a personal response from the students, offering them the space to blend of in and out of school experiences and draw from their own experiences.

Drawing from the format of graphic novels, which—like sound-photos—blend two modes to create meaning, four of the student participants were invited to create a story in a sound-photo sequence. These were chosen (from volunteers) to reflect the gender, ability and ethnicity mix of the class. The aim of this further task was to put the composition process into a very different context, giving the students yet more freedom in terms of their topic foci. For this task, each student was challenged to collect six photos which, in sequence, could tell a story. They were permitted to obtain these images from anywhere they wanted, either using their own photography or by sourcing photos online. The device app was connected to a website service which allowed sharing of materials. Stories composed from collected material were uploaded by the researcher to a dedicated webpage.

The Narrated Photograph: Student Products and Reflections

When asked about the nature of their own photo sharing practices, students referred to "selfies" and "memes". "Selfie" is the familiar term for a photograph taken by the photographer *of* the photographer. While memes are typically humorous photos where the content resonates with some topical and shared idea. To analyse the students' activity, Stein's (2008) research on multimodal pedagogies is helpful. Those ideas are suggested through two approaches that the students reveal in relation to artefact composition: narrative and conceptual. Memes (pictures with the purpose of sharing an amusing idea) fit more into the narrative category, described by Stein as "… representing the world in terms of 'doing' and 'happening'" (2008, p. 67). Selfies, however, seem to be more about conceptual representations, "… representing participants in terms of their classification, their generalised states of being or essences" (2008, p. 67).

Materials were evaluated in class, using an interactive whiteboard to look at examples as a whole group, as well as to focus on what was thought to make an engaging image and what makes engaging speech/sound (vocal qualities such as pitch, pace, volume and tone). Following this the students looked at each others' work in teams. Students were given a set of questions to evaluate photos, such as "How engaging is the image?" "How effective is the sound?" "Do the sound and image link?" "Does one sound photo link to the next?" In their group reflections, the class first focused on the photo image. Students were eager to give feedback and engage with their classmates' compositions. However, very few were able to justify their opinions in any detail and seemed to lack the relevant vocabulary to articulate their evaluations. It was evident from these sessions that students' sensitivity to visual composition was relatively underdeveloped and they showed limited inclination to use visual structure as a platform for "reading" what was depicted.

Yet with minimal prompting, students still proved to be highly engaged with the process of evaluating these multimodal compositions. Whilst some student feedback focused on one mode at a time, a number of examples considered the sound and photo elements as two parts of a whole and reflected on the impact of that "whole" production. Throughout the viewing session that was organised, students played their peers' sound clips repeatedly. There was a definite focus on the sound mode of the compositions, over the image mode.

Madsen and Potts (2010) note how an uncertainty about recorded speech can reflect the very exposing and intimate form of this representation. So they note how in the podcast listening experience: "The acousmatic voice is poured into the ears without disruptions from the exterior world, enveloping the listener with the intimate expression of its character—its grain …" (2010, p. 45). They suggest that even when detached from its physical body, the voice remains unique and personal to the speaker. When used as a stand-alone mode of communication, speech offers nothing for the producer to hide behind, with listeners often concentrating on the qualities and sounds of the words spoken "… before the content is even considered" (2010, p. 45).

Moreover, individual students seem to be particularly concerned about the qualities of their voice and how listeners would "judge" the way it sounds, rather than the content of the speech they delivered. For example, Raven (names are anonymised) chose an inspiring subject matter for one composition: an ice cream parlour that uses liquid nitrogen to create its product. However, the opportunity to capture unusual chemical process behind the ice cream is neglected, offering instead just an image of the shop sign (Fig. 2.1). The image offers only a label or a headline for what is spoken to accompany it. This was a common approach to opening up an idea.

A multimodal "object" equates to more than the sum of its parts. A sound-photo composition would thereby communicate meaning through the intersection of sound

Fig. 2.1 Image from sound photograph

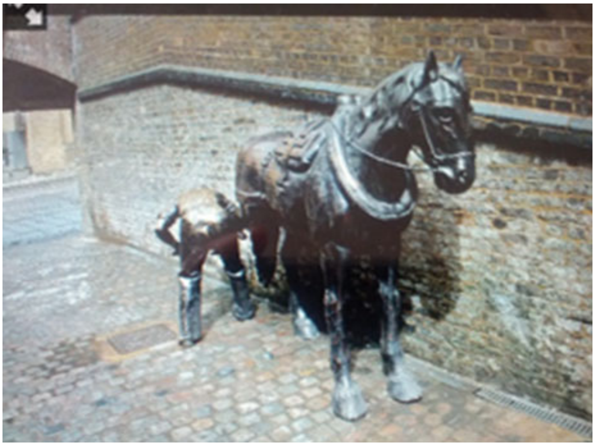

Fig. 2.2 Image from sound photograph

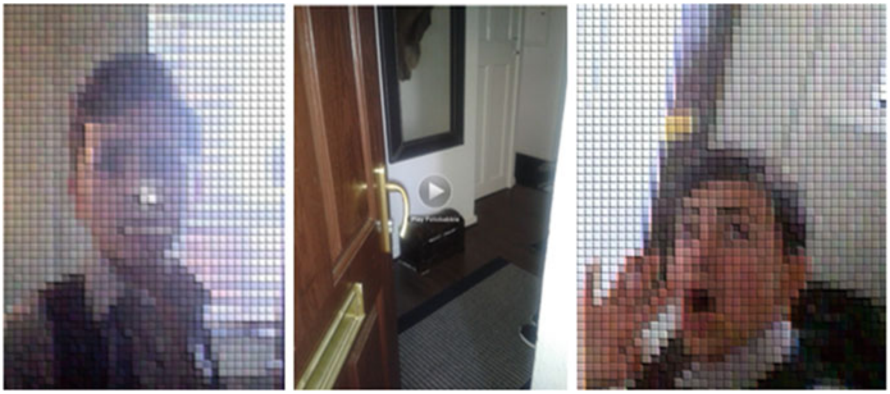

Fig. 2.3 Section of sound-photo narrative

and image; one influencing the other. Yet very few examples of students' compositions demonstrate a tight integration of these two modalities. Most of the photos taken were self-explanatory, omitting opportunities for further viewer reading. With nothing provocative to draw from, it is then unsurprising that students' struggled to intersect their images with speech. So Meher's recording simply describes the contents of their image (Fig. 2.2) in an expository manner. It fails to communicate beyond the information available through listing material details depicted in the photograph.

Although students were uniformly engaged, the creative exercise of multimodality was limited for most of them. There were, however, some students who rose to the challenge in an inventive manner. Altin's sound-photo narrative revealed a sophisticated understanding of shot type and camera angle. He effectively employs close ups to focus on the fear in his victim's face, POV (point of view) shots to give the impression that the reader was looking at the crime scene from characters' perspectives and a high angle shot to highlight his victim's weakness.

Through this understanding of what the photo image can achieve, student Altin produced a series of images that invited speech (and even sounds) that could enrich meaning, rather than reiterate it. Characters voices, a narrator, the sound of the door opening and even music could all intersect with these images to alter and enrich their representations.

Compositions such as those in Figs. 2.1 and 2.2 show that with limited appreciation of the image as a semiotic resource, students can struggle to exploit its potential and use it in conjunction with other modalities, such as speech. Meanwhile, Altin's composition (Fig. 2.3) shows that with developed visual confidence, students can use image and sound together to create sophisticated, multimodal texts.

Through sound-photo composition, students were challenged to adopt an instrumental use of voice, exploiting its unique semiotic resources, e.g. pace, pitch, tone, volume, rhythm and emphasis. A semiotic reading of compositions revealed great disparities in students' access to these affordances. However, they also revealed new learning opportunities made possible through working in this mode. Some students proved quite resistant to the mode of speech, producing sound-photo compositions that were far more limited than their written classwork. Some offered no speech at all whilst others employed other people's voices, or even alternative sounds. Cavarero (2005) discusses the performative nature of recorded speech and claims that through this mode of representation, there is "… a communication of one's own uniqueness that is, at the same time, a relation with another unique existent." (Cavarero, 2005, p. 5). It is this "uniqueness" that some of the students seemed to fear, both in terms of the unique qualities of their own voices, as well as the unique experience that an audience would have, listening to their voice.

Whilst most compositions adopted a style fairly similar to natural, conversational speech, several examples attempted more complex, sophisticated speech registers. Two students chose registers similar to that of a television advertisement, seducing their audiences with persuasive language and tone. One demonstrated multiple examples of the persuasive register in describing the local food market, referring to the "rich and fine aroma from the food stalls" and the "strong scent of spices", freely using alliteration. Another used endearing adjectives such as "spectacular" in a sound-photo about his local park, encouraging his audience to "relax on the hills".

Such examples demonstrated that students' confidence with speech registers varied greatly. Although the Drama curriculum does focus on speaking skills, it is not a compulsory subject. As a result, many students may leave school with limited oracy confidence. The variation observed suggests the need for more explicit focus on speaking-for-purpose in the English classroom. Wissman argues that "There is a value in co-constructing a student-centred space where the texts of students' lives become the texts of the class" (Wissman, 2008, p. 41) as it empowers and engages, promoting "the learner as interpreter" (Kress, 2009, p. 26).

Discussion

Through encountering new modes of meaning-making, students may be able to represent in ways that would not be possible through writing alone. The case study outlined above illustrates how such opportunities might play out at the present time. So the sound-photo composition activities enabled these students to employ new speech registers to engage their audiences in different ways, adding meaning to their words. This variation in voicing reminds us that education creates few opportunities for students to think about their speech in instrumental terms. Yet we saw in some of these students a willingness and ability to do this. Adapting speech for purpose is a fundamental social skill. Thus, there is a need to take oracy more seriously and to see digital tools as one opening to do so in a practical way.

Likewise, this project revealed disparities in students' confidence with visual expression: differences that implied a lack of experience in seeing the semiotic potential of the image. These observations suggest that educators should help students read (and compose) in this visual modality as carefully as they are helped to read and write.

The responses of students referred to here make it evident that multimodal composition is not something they associate with English lessons: their concept of the subject is firmly anchored into communication through the single mode of writing. Yet despite the students' limited ability to imagine the role of sound-photo composition in the formal context of "English lessons", they were able to express the benefits it offered to acts of meaning-making. In particular, they observed that all modes carry with them different semiotic resources and some modes may be a more effective in certain contexts than others. For example, student Altin argued that activity in a park is more vividly conveyed through a sound recording, and written words cannot capture the same atmosphere:

> Like, if you're in the park and you can hear laughter and people having fun, then you like, like, you can imagine it in your mind and how, how it feels like. But, like, in writing, you wouldn't really feel like, um, like you can really imagine it in your mind and try and focus on it.

Moreover, these students agreed that layered modes can strengthen meaning making (Millar & McVee, 2012). This is demonstrated in Altin's suggestion that layering speech with sound allows the speaker to direct the audience's attention to particular foci within the image:

> … if you can hear it and look at it then you like know, ah, this person's talking about this and this and this. But, like, in writing, you don't really know what position they're in, like, where they are, you don't know what to focus on …

Finally, in addressing these pedagogical issues, it is also necessary to consider how this experience informs best practice for future projects on multimodal learning. One issue is the provision of more guidance but also a more prescriptive task to establish confidence. A second issue is how it should be assessed? The sound-photos illustrated in the case study here cannot be easily mapped onto the traditional reading/writing assessment criteria. Jacobs (2013) proposes a need for change in assessment to align with changes in communication practices, claiming that "… it is not enough to provide opportunities for youths to engage in multi-literacies; assessment of multi-literacies must also be meaningfully integrated into the classroom" (2013, p. 623).

Seigal (2012) attempts to address the complex nature of multimodal assessment, stressing that the ultimate factor in designing assessment should be that there are multiple ways to make meaning. With this point in mind, she states "It is critical, therefore, that teachers and students become skilled readers of multimodal designs in all their variety" (2012, p. 676). She also suggests that for multimodality to be taken seriously in education there needs to be more open discussion that raises questions and considers the nature of multimodal classroom practices. We hope that we are contributing to that debate.

Conclusion

We have described a project design for engaging secondary school students with multimodal interpretation and expression. This is achieved through the curation of a distinctive artefact—the narrated photograph. This unusual artefact emerges as a challenging yet effective way of capturing interest and imagination. It echoes very familiar digital formats and yet it is sufficiently unfamiliar to stimulate curiosity and engagement. The project was shared with the students' tutors and a presentation was made for other members of the subject department. There are good grounds for supposing that multimodal projects designed around the principle of narrating images can be attractive to students and a rich vehicle for teachers.

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Chapter 3
Introducing Digital Technologies into Secondary Schools to Develop Literacy and Engage Disaffected Learners: A Case Study from the UK

Helen Boulton

Abstract This chapter reports a project, Literacy and Technology: Towards Best Practice, funded by the UK's Teaching Agency, involving five secondary schools in the East Midlands, UK. The project introduced digital technologies into core curriculum subject classrooms: science and English. The aim of the project was to identify whether new technologies, introduced into Key Stage 3 classrooms (11–14 years), could raise literacy levels of students with special education needs or disabilities (SEND), learning in a second language (EAL), with low levels of literacy, or identified by their school as disengaged with learning. The project proved successful with raised literacy levels and improved engagement in learning resulting in improved levels of progression. This chapter discusses the adoption, design and development of the use of new technologies.

Keywords Secondary school • Pedagogy • Technology • Literacy • Engagement • Digital technologies • Disaffected learners • Literacy and technology • Core curriculum subject areas • Science • English • Literacy levels • Special education needs • Disabilities • Second language (EAL) • Progression

This chapter reports a project, Literacy and Technology: Towards Best Practice, funded by the UK's Teaching Agency,[1] involving five secondary schools in the East Midlands, UK. The project introduced digital technologies into core curriculum subject classrooms: science and English. The aim of the project was to identify whether new technologies, introduced into Key Stage 3 classrooms (11–14 years), could raise literacy levels of students with special education needs or disabilities

[1] The Teaching Agency was responsible for training new and existing teachers in England; recently merged with the National College for School Leadership.

Type of contribution: case study encompassing five schools.

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(SEND), learning in a second language (EAL), with low levels of literacy, or identified by their school as disengaged with learning. The project proved successful with raised literacy levels and improved engagement in learning resulting in improved levels of progression. This chapter discusses the adoption, design and development of the use of new technologies.

This chapter begins with an overview of the project and a review of key literature relating to the use of digital technologies in the secondary classroom, including a critique of the digitally literate student and potential barriers to the introduction of new technologies in schools. The chapter then gives background information on the schools in the project including students and teachers, detail of the technologies that were used, why each technology was chosen, and how the teachers were trained and supported. There is then a discussion of how the technologies were introduced and implemented in the classrooms, subject content, the affordances of the technologies in learning and teaching, emerging pedagogy and considerations for teachers wishing to replicate this usage in their classrooms. The final section includes a discussion of the overall outcomes of the project and suggests that digital technologies can provide a more flexible and creative learning opportunity.

Increased use of Web 2.0 technologies across Europe has resulted in a developing body of research into how these technologies are integrated into the classroom (Angeli & Valanides, 2009; Bennett et al., 2012; Bingimlas, 2009; Byrd-Blake & Hundley, 2012; Luckin et al., 2012; Niess, 2005). Reference to learners with perceived digital literacy skills, knowledge and understanding is varied. There is continued criticism in the literature around the technological capability of twenty-first century students who some see as digitally capable and others view as being good at using social media, but not in the application of technology to learning. For example Prenksy (2001) claimed young people were digital natives having grown up with technologies and being confident in using a range of technologies. Bennett, Maton, and Kervin (2008) and Kirschner and van Merrienboer (2013) countered this argument, while Jones, Ramanau, Cross, and Healing (2010) argued that new technology use by young people is far more complex than the digital native portrayal. The view of teachers' capability has also been identified through literature such as Prenksy (2001) aligning teachers to digital immigrants in that most had not grown up with technologies, and Young (2010) identifying an increase in self-proclaimed "digital luddites" among teachers. There is now recognition that students in schools need to use a variety of digital technologies to enable them to become digitally wise (Prensky, 2010).

There is also much in the literature relating to emerging pedagogy and the use of new technologies. For example Tapscott (1999) identified that technologies support a changing pedagogy from teacher-centred to learner-centred. Mitra et al. (2005) who conducted research using hole in the wall computers found that young people could teach themselves how to use technologies. Thomas (2011) identified that learning new technologies tended to be incremental rather than revolutionary.

The successful use of technologies in school classrooms indicates that the integration of technologies in classrooms is still in need of development (Hutchison, 2012; Lawless & Pellegrino, 2007). Some researchers have identified that many teachers restrict their use of technologies to presentation software, appropriate websites and school management tools (Harris, Mishra, & Koehler, 2009). There is criticism in the literature relating to whether use of technology in the classroom can actually be transformational and engage learners (Kirkwood & Price, 2013) and criticism about the measured impact of technologies in the classroom to support learning (Angeli & Valanides, 2009; Higgins, Xiao, & Katsipataki, 2012). Indeed, Harris et al. (2009) argue that the use of technologies in classrooms tends to be focussed on skills required by teachers rather than students' learning needs. Researchers such as Livingstone (2012) report mixed success when using technologies to improve students' performance.

The framework for introducing this project to teachers focussed on that developed by Mishra and Koehler (2006), which identifies the importance of pedagogy, lesson content, and confident use of technology (TPACK) by teachers, has been applied by other researchers and found to be an appropriate framework. This is supported by Higgins and Parsons (2009), Kramarski and Michalsky (2010) and Kennedy and McKay (2011) findings that professional development which integrates pedagogy and ideas within the context of the teacher's practice is more likely to ensure success. While Richardson (2010) comments on the need for teachers using new technologies to gain a better understanding of pedagogy and effective use of technology in the classroom before teaching with them. However, there are critics of the TPACK model, for example Archambault and Barnett (2010) argue that teachers can find it difficult to integrate each of the aspects of pedagogy, content knowledge and technology, thus questioning whether this can be useful. Graham (2011) also questions the validity of the TPACK framework and whether researchers can establish a clear rationale for the integration of each aspect of the framework.

Moving to more general professional development related to the use of technologies in school classrooms Bingimlas (2009), Drent and Meelissen (2008), Liu (2013) and Boulton and Hramiak (2014) identified that teachers need to be supported and may benefit from working collaboratively with others. In this project support and collaboration was provided throughout the project through the pairing of teacher with pre-service teacher and through the role of the university tutors who worked with each pair in their schools to support the project and create a supportive environment. Byrd-Blake and Hundley (2012) identified the need for teachers to agree learning goals which focussed on student outcomes for technology integration in learning to be successful. In this project the learning goal for the teachers was using technologies to raise achievement in literacy and engage disengaged learners, thus a clear focus on improved results for students leading to increased social inclusion.

Project Overview

The project was led by a University, who has been involved in pre-service training for over 50 years and has a strong record of working in partnership with schools. In each school one teacher, a subject expert, was paired with a pre-service teacher with a strong background in computing and able to provide support in using new technologies. Head teachers were invited to put forward an expert teacher in one of the core curriculum subjects: mathematics, science or English. No previous experience of using digital technologies was required of the expert teacher, rather a willingness to develop skills and work with a pre-service teacher who would provide support in setting up the technology and providing support in the project intervention lessons. Brief contextual information relating to each school is set out below:

School A was an Academy for children aged 3–18 years with approximately 50 % of students White British and half from minority ethnic backgrounds, over 25 % with English as an additional language (EAL), and approximately 40 % with special educational needs and disabilities (SEND). The group chosen for the project was a year 8 (12–13 years) mixed gender literacy class with 22 students, eight of whom had English as an additional language (EAL) and four students identified by the school as disengaged with their learning. The group was working at National Curriculum (NC) literacy levels 2–4, which is below expectations (levels 4–5 being the expected level). The content knowledge focussed on writing persuasively and developing key language features. The chosen technology to support the lessons was PiratePad which facilitates real-time collaborations allowing students to simultaneously edit a text-based document amending and improving their own and peer's work, with a chat facility which provided opportunity for additional communication.

School B was a church funded school for 11–18 year olds. For the project a year 7 (11–12 years) literacy intervention class was chosen. This group comprised 15 girls who were identified by the school as having low literacy levels with 56 % working at below NC average reading age by 2 years. The chosen technology was a wiki, collaborative software which allows authors to create and edit developing ideas, concepts and understanding. The subject content focussed on creative writing and writing summaries. The wiki was chosen as it would allow students to develop their own work and also work collaboratively thus providing opportunity for peer feedback and extended learning beyond the classroom.

School C was a state school with students aged 3–19. The group chosen was a year 9 (13–14) mixed gender group. There were 18 students, 12 who were EAL with first languages including Bengali, Polish, Slovakian, Chinese and Portuguese. Eight students were on the Special Educational Needs (SEN) register, with seven students receiving individual additional support and four students identified by the school as disengaged with learning. The students in the class were working at NC literacy levels 2–4; the norm would be levels 5–6 for this age. The subject content was the development and understanding of poetry. Two technologies were chosen: PiratePad, and Corkboard. The content knowledge was poetry, specifically identifying and developing elements of poetry such as synonyms, onomatopoeias and metaphors.

School D was an 11–18 Church school. The group chosen was a year 9 science group with 14 students. Five students were working at below NC literacy levels (levels 2–4) and two were identified as disengaged with learning. The subject content was different methods of metal ore extraction and reactivity; this involved working in groups to complete experiments which students then wrote up individually. PiratePad was chosen because it enabled real-time collaboration, Wordle, a technology which generates word clouds from text to identify key elements of the experiments, and Corkboard as a plenary tool for individual research to be shared with the group.

School E was a church school for 11–18-year-olds. A year 9 science group was chosen which had 20 low ability students, seven of whom had special education needs and disability (SEND) and five who were disengaged with learning. The students in the class were working below NC literacy levels for the UK. The chosen technologies were a wiki and Wordle.

The first stage in the project was to pair each expert subject teacher with the pre-service teacher and identify their roles. While the roles were not prescriptive each pair worked in a similar way. The expert teacher identified the content knowledge and developed the subject element of the lesson and resources. The pre-service teacher set up the technology for each lesson and uploaded subject knowledge resources. Working together each pair developed the lesson plan and identified appropriate pedagogy to support the lesson. In each school the expert teacher delivered the lesson, with the pre-service teacher providing support when the students were using the technology(ies). Reflections on the lesson and planning for the following lesson were carried out collaboratively. By the end of the project the expert subject teacher had gained sufficient confidence in using the technology(ies) that they no longer required additional support of the pre-service teacher. The impact on the teachers and pre-service teachers is discussed later in this chapter.

An initial training session for the teachers and pre-service teachers was held at the start of the project. The training session provided opportunity to demonstrate a variety of Web 2.0 technologies and engender discussion related to how these could be used to support learning in the classroom and identify appropriate pedagogy. The training involved including reference to the Technology Pedagogy and Content Knowledge framework (Mishra & Koehler, 2006) which identifies the importance of pedagogy, lesson content, and confident use of technology by teachers. The teachers and pre-service teacher then identified which class(es) would most benefit from involvement in the project. A discussion followed to identify the Web 2.0 technology most appropriate to the topic being taught; to identify how the impact on student learning would be recorded and the challenges affordances of the technologies they planned to utilise. This was then shared across the group and an opportunity to explore further technologies.

The projects in each school then commenced. Two of the projects are detailed below, information on all of the projects can be found at www.itte.org.uk.

School C

This Year 8 English group were working on a project which focussed on poetry writing in preparation for Year 9 studies, focussing on identifying and understanding the use of metaphors, similes and onomatopoeias, then writing different styles of poetry or song using each of these elements. The teacher and pre-service teacher had decided to use PiratePad and Corkboard for students to share the themes of their poems/songs. Both technologies enabled out of school learning through continuing on the development of their poem/song and sharing these for peer feedback as homework. Initial preparation involved setting up both technologies and testing access through the school's firewall using a student's log in details. The expert teacher wanted the students to work in ability groups rather than friendship groups so that he could use PiratePad for differentiated learning. The expert teacher grouped the students appropriately into six groups and pre-service teacher therefore set up separate PiratePads for each group. The expert teacher identified the URL would be too long for the students to copy correctly so it was shortened through an online link shortener. A board was also set up using Corkboard so that each student was able to upload the title of their song/poem or upload an image which represented their song/poem; the latter choice particularly supported the students who were working in their second language with little English having arrived in the UK within the last 12 months.

There was initially some concern from the expert teacher that PiratePad had a chat facility which he viewed as potentially disruptive through students chatting off task. The students were able to utilise the chat facility to ask each other questions relating to the topic and clarify misunderstandings of language through working in their second language. There was also a teaching assistant (TA) in the lesson who was able to monitor the chat area and identify quickly who needed help. In the evaluation it was evident the teacher had really identified how to harness the chat area to ensure students were engaged, on task and understanding the lesson content.

Much of work in this project was completed in groups. Group work without technologies requires students sitting in the groups in class and normally there would be a higher level of noise which can result in some students losing concentration. With the use of the technologies students did not need to sit in their groups; all conversation was online through the chat area and through the co-creation of online documents. Both students and teachers commented positively on the different atmosphere in the classroom created by this use of the technologies. The students reported a positive impact of using the technologies in learning. All of the students believed the technologies had helped to improve their literacy and achievement of the learning outcomes and they reported enjoyment at being able to share their work and communicate through the technologies. They particularly liked the online chat facility to support each other in their learning. Several students described learning through the technologies as "*fun*". The students also found a benefit of being able to look up words using online dictionaries was that their spelling improved. Their learning style became more creative as the students found the technologies aided their imaginations; they particularly enjoyed using images in Corkboard to share their ideas for their poems which they said added to their creativity.

Student 1 commented: "*I liked using this technology because I could work in a group but the teacher could see what I had done so I still got credit for my own work*".

One group of four girls said they liked communicating with their friends, and making new friends in their groups. They liked the way the software highlighted their work. One student commented:

> *Rather than having to go and ask friends you can send them a chat.* (Student 3)

> *Much better because it makes you think more'. 'It is improving my work particularly English.* (Student 8)

However, students also reported some negative impact which included frustration if their computer crashed (reported by two students). Some students abused the chat feature to have general conversations instead of focussing on the work set. The teacher and TA were quickly able to stop misuse of chat by establishing and embedding expectations. Initially some of the students were distracted by the multimodal nature of the internet. In a follow up interview the teacher said having used the technologies he would develop a set of user rules which would lead to shared expectations when using Web 2.0 technologies.

The pre-service teacher found that the students enjoyed using the Web 2.0 technologies and were eager to understand how the technologies could be used in learning. He also identified that when using the technologies the TA could follow the online chat and see which students needed help. The TA could therefore support other more students when using the technologies. He particularly noted that the students were able to engage with students they had not previously worked with through the technology commenting: "[The technologies] *enhanced a collaborative working environment and allowed students to mentor and support one another. The laptops aided low ability and EAL students as they could research good examples of poetry*, *translate words and visualise things through Google images*."

The expert teacher had rarely used technology in teaching prior to the project and had lacked confidence in finding and using appropriate technologies to support his subject. He had previously only used slides and word processing. This project had given him confidence in using technologies. He commented:

> This is very different and I think it is more exiting and engaging for the students. It was great to see students supporting each other and allowed me to have more time to talk to students as individuals and facilitate learning rather than being at the forefront of their learning.

He was particularly aware of the quieter, more purposeful atmosphere in the classroom when students were working collaboratively with the technologies. He commented very positively on how the students used translation websites to help them with their writing, establishing good practice for when they were doing homework. The teacher commented positively on the progression of the students who all achieved their learning outcomes and achieved at least one level higher in literacy than they had been predicated.

School D

This group was a small Year 9 science group with 14 students working below national average in literacy or disengaged with learning. The subject content was different methods of metal ore extraction and reactivity. The lessons involved students working in groups to complete experiments which the students then wrote up individually. A wiki was chosen by the expert and pre-service teachers because it enabled real-time collaboration, supporting the pedagogy for the lessons, Wordle to identify key words from the write up of the experiments and Corkboard as a tool in the lesson plenary for individual research to be shared with the group.

Prior to the lessons the pre-service teacher set up a wiki with a main page containing the information for each experiment, guidance for the students to follow and an additional page for each student to access. Each student's page had the same tasks

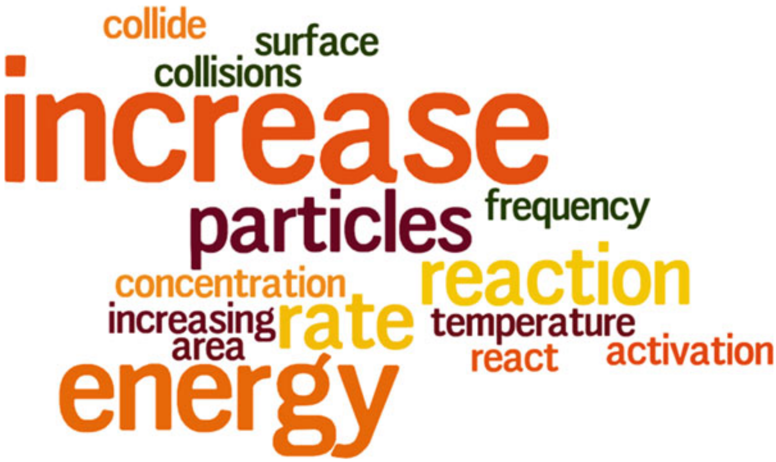

Fig. 3.1 Lesson 1 Wordle

Link to the Wordle for this lesson

(PASS TASK) Starter activity:

Using the Wordle above, assign the correct key words to the following definitions and questions.

1) Particles need to do this to react
2) How fast or slow a reaction is
3) The minimum amount of energy particles need to react
4) How many particles there are in a certain amount of space
5) Breaking up a solid into smaller pieces increases this
6) This makes particles move around faster

Fig. 3.2 Lesson starter activity

displayed on it. A Wordle was created for each lesson starter, see Figs. 3.1 and 3.2; the first lesson was created using the text from the main page of the wiki and further lesson Wordles were created from student's write-up of the experiment. Hard copies of both the wiki information and the Wordle were also provided as a strategy to support students who might find difficulty in moving between platforms. As additional support a help sheet with instructions, including screenshots, of the main task was also created. The screenshots were differentiated to support different abilities and were particularly useful to those who were working in their second language. Slides with differentiated learning outcomes and key learning points were also produced for use by the teacher in the initial stages of the project and at key points during the lessons. Figure 3.3 shows the main activity for lesson 1 of the project.

Main activity:
Read the text below and then complete the activities

Rates of reaction
The rate of a reaction can be measured by the rate at which a reactant is used up, or the rate at which a product is formed.
The temperature, concentration, surface area of reacting solids, and the use of catalysts, are all factors which affect the rate of a reaction.
Chemical reactions can only happen if reactant particles collide with enough energy. The more frequently particles collide, and the greater the proportion of collisions with enough energy, the greater the rate of reaction.

The rate of a reaction increases if:

The temperature is increased. This is because the reactant particles move more quickly and have more energy.

The concentration of a dissolved reactant is increased. This is because there are more reactant particles which increases the chance of them colliding.

Solid reactants are broken into smaller pieces which increases its surface area. This means more particles are exposed to the reactants and there is a greater chance of the particles colliding.

A catalyst is used. Catalysts lower the energy particles need to react. Catalysts do not get used up in a chemical reaction and different catalysts are needed for different reactions.

Fig. 3.3 Lesson 1 main activity

The benefits of the project to the expert teacher at this school were in seeing the students, who often struggled in class, being able to access the lesson and complete work more creatively through the technologies. The teacher stated that the level achieved for the students was much improved through the wiki. Final testing of knowledge and literacy levels indicated that the students had gained at least one level higher than predicted which the teacher said was due to the increased level of engagement and understanding through using the technologies. The teacher also commented that the TA who was timetabled to provide additional support with this class in science lessons had commented that she provided less support than usual when the technologies were being used stating:

> *It was really interesting to see how students in a normal classroom would struggle with the work rate but how these same students embraced the wiki and engaged in the activities set via the wiki. Notably, there were a number of students in that class that would normally struggle to engage with written activities in a normal science lesson but they did so extremely well via the wiki.*

The group at this school also had a student with severe physical difficulties that resulted in her not being able to write. One to one TA support was provided to write for her which the student found frustrating. The TA commented that for the first time the student had managed to access all aspects of the lesson without her support due to the use of the technology. While the student could not hold a pen, she was able to use a keyboard and mouse. The TA stated: "*I have been delighted with the progress of* [*the student*] *who has always struggled to write and keep up with the teacher. Having seen the impact of the technologies in this lesson I will investigate using them in other subject areas*".

The students were asked to take part in focus group interviews at the completion of the project to identify the impact of the technologies on their learning. The students all commented that they found the sharing of work and collaborative aspects of the use of the technologies enabled the students to progress faster and felt they had learnt subject content at a deeper level. The students also suggested that this social constructive approach to learning was more enjoyable. They found that using the wiki was a positive change from the usual science lesson: "*everyone would be working on their own and just asking the teacher if they got stuck, however by using the wiki, everyone was helping each other out. We learnt more and moved on with the tasks without having to wait for anyone*" (Student 6). Student 8 commented: "*I found the wiki was a good tool for the peer assessment task as it allowed the me to read immediate comments on what I had done wrong on the first task before I moved onto the next task.*" Student 9 who was identified as disengaged with learning commented that: "*it's much better* [using the technology] *than being in a lesson*". Other students, such as Student 13, stated: "*I prefer working on the wiki because my work looked much neater*", while Student 14, who was identified as having a below average reading age, used the copy and paste function of the wiki in the plenary task to speed up correcting his sentences and commented: "*this was a real benefit*".

The pre-service teacher, although science was not her subject area, found she had gained greatly from the experience of working on the project. She found that the project helped her to identify several key areas relating to her professional development; access to the lesson content through using technologies can, and often does, impact on the motivation of students; web based technologies can offer an innovative means to engage and motivate students in pursuit of progress; the importance of listening to students and their understanding of how tasks can be made more engaging; and that when faced with a class of seemingly uninterested students that have low expectations of their own capability, the consideration of alternative teaching and learning methods, supported by new technologies that will enthuse, motivate and engage students should be sought.

Unexpected Consequences

There were some unexpected consequences that emerged from the project. For example the teachers and pre-services teachers expected students would welcome the increased use of technologies in learning. However, their expectations were exceeded with a much higher level of engagement and achievement of learning outcomes. As a result the teachers disseminated the outcomes of the project within their schools and also revisited other technologies they had been exposed to in the initial training session. This enabled them to identify a range of technologies appropriate to their individual classroom and subject context. For example School D started to send out a Tweet of the Week for students and parents, which has steadily grown in popularity spreading to other subjects, and explored technologies such as mind mapping and animation software.

Most of the technologies facilitated student-centred learning reflecting Tapscott's (1999) view that technologies move learning from teacher-centred to learner-centred. The students enjoyed learning and creating knowledge in groups, identifying a key affordance of many new technologies; the way in which many of the technologies record individual contributions to group tasks. The English teacher had been concerned at the outset of the project that students used "slang" when using new technologies such as MSN and Facebook and they may project this onto their school work. There are many complexities around using different types of English language in different situations, however the school's expectations of the correct use of English, reinforced by the teacher at the start of lessons, resulted in the use of correct use of English in most of the student's work. However, when the chat facility in PiratePad was utilised students reverted "slang" English reflecting their use of social software outside school. Before using chat facilities teachers may want to establish a set of principles such as "no slang".

All of the teachers were surprised at the increased level of intrinsic motivation, particularly from girls, when the new technologies were used. Teachers also commented on the improved "pace" in lessons when the technologies were used which again reflects the notion of increased student-centred learning when technologies are adopted. Other learning from the project included the need to manage individual student's opportunity to copy work; this is easily identified but would need including in a set of principles for using new technologies. Students could also delete the work of others; again this needs managing by the teacher. There were difficulties experienced by some students in reading a lot of text on the screen. However, new technologies do allow for audio or video to be embedded which would provide additional support for these students.

The impact on pre-service teachers was also surprising. The purpose of their involvement was to help them to develop a greater awareness of lesson planning and an opportunity to reflect collaboratively with an expert teacher outside their own subject area. However, all of the pre-service teachers identified an improved understanding of cross-curricular work and the development of digital literacy skills with an improved knowledge of pedagogy when using new technologies. The pre-service teachers also welcomed the opportunity to support teachers who were not experts with using technologies, reporting this developed their leadership skills. The project focussed on expert teachers and pre-service teachers, but the impact of the project extended to TAs. The TAs, once they saw how the students they supported could be more independent learners, achieve at a higher level and were more engaged, became excited about the potential of technologies in supporting SEND and EAL and have continued to explore and use new technologies in other subjects. As a direct result of the project at both schools TAs have been included in professional development focussing on using technologies and are now frequently asked for advice about the most appropriate technology for the students they support.

While the overall impact of the project was positive with students achieving higher levels, exhibiting deeper levels of understanding and finding learning with new technologies both motivating and fun it is important to acknowledge that this was a small project affecting only one subject in each school. It was not possible to identify whether the students would become bored and disengaged if technologies were used more widely and become the norm for twenty-first century learners as did the chalkboard for twentieth century learners.

Conclusion

This project supports the findings of others, that technologies have the potential to raise the achievement of students, increase their engagement in learning and result in a greater enjoyment of learning. This project has also shown that technologies can be used to support an increase in literacy levels and provide additional support and opportunity to access learning for SEND and EAL students. However, to achieve success careful planning is required and teachers need to adopt a framework such as the TPACK framework to ensure that they introduce technologies appropriately. This project indicated that TAs should be included in planning for technologies so they also develop confidence in using a range of technologies which will enable them to provide teachers with knowledge on which technologies to use with the students they support.

Technologies can support more creative working for example technologies can help EAL students as they can translate language which helps them to develop their literacy skills. Collaborative learning and social construction of knowledge can be facilitated through many emerging technologies. Students enjoy sharing each other's work and being able to provide feedback; new technologies can support teachers and provide more creative ways of planning for peer feedback which engage learners, thus actively involving students in learning development and processes of co-creation challenging learning relationships and harnessing interactions outside the formal curriculum.

In the UK we have increasing numbers of students for whom English is their second language. This creates tensions and challenges for teachers in their planning. The use of new technologies could provide opportunities to rethink how we support these students decolonising education and moving towards new pedagogies to extend intercultural understanding and developing transformative approaches to learning. However, teachers need support in using new technologies in learning and teaching and developing confidence in using a range of technologies appropriate to their individual classroom context and subject. We need a workforce of teachers that are digitally wise with regular training on new technologies and opportunities to share professional development, as well as modelling excellent use of technologies both for pre-service teachers as part of their training and once qualified. Our education needs to be future-facing refocussing learning and teaching to consider emerging technologies to engender greater creativity.

We finish this chapter with a final comment from the teacher at School D:

> [The project] *has left me with a perpetual understanding of how using Web 2.0 technologies can be utilised in the science curriculum, across all key stages, not only to promote literacy but also active involvement and collaborative working. The enjoyment of students involved in this project was paramount to being inspired to make further use of technologies*.

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Chapter 4
Transforming Mathematics Teaching with Digital Technologies: A Community of Practice Perspective

Alison Clark-Wilson

Abstract Dynamic mathematical digital resources promise a transformation of the teaching and learning of mathematics by enabling teachers and learners to experience and explore difficult mathematical ideas in more tangible ways. However, reports of classroom practice reveal an underuse of such technologies—particularly by learners—and research findings articulate the complexities of the process of classroom integration by teachers. The work described in this chapter is set in the context of a large-scale multi-year study, *Cornerstone Maths* (CM), which aims to overcome known barriers to technology use in lower secondary mathematics with the professional development of the participating teachers as a central tenet. Here, the design and implementation of the CM professional development as experienced by a group of four teachers from one school's mathematics department is examined from a Wengerian perspective as a means to understand the trajectories of teachers' growth in both their mathematical knowledge for teaching and their associated emerging mathematical pedagogic practices with technology.

Keywords Transformation • Mathematics teaching • Digital technologies • Community of practice • *Mathematics* • Learners • Classroom integration • Teachers • Learning environment • Barriers • Professional development • Wenger • Subject content knowledge • Pedagogical practice

Introduction

The advent of dynamic mathematical digital resources in the early 1990s promised a transformation of the teaching and learning of mathematics as the technology enabled teachers and learners to experience and explore difficult mathematical ideas in more tangible ways. A host of digital environments and resources has resulted, but as research studies and school inspection reports ensued, it was soon evident

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that this process of transformation was far more complex than originally anticipated. The early wave of innovative practices and the enthusiasm of the innovators were not sufficient to bring about long-lasting changes in the prevailing classroom practices of many countries.

The Cornerstone Maths (CM) project (2010–2013) was conceived to respond directly to this situation by adopting a *design-based research* approach (Penuel, Fishman, Cheng, & Sabelli, 2011) to produce a set of curriculum units that exploit the dynamic and multi-representational potential of digital technology to address known "hard to teach" topics in 11–14 mathematics: linear function; geometric similarity; and algebraic patterns and expressions (Hoyles, Noss, Vahey, & Roschelle, 2013). The resulting curriculum units comprise: specially designed web-based software; student workbooks; teacher guides; and a mandatory professional development (PD) programme. This paper describes outcomes from an ongoing Nuffield Foundation-funded CM project that is being co-directed by my colleague Celia Hoyles and I. The study aims to analyse the development of teachers' *mathematical knowledge for teaching* (Hill & Ball, 2004) and associated mathematics pedagogical practice as they engage in professional development and teaching of the CM curriculum unit on algebraic patterns and expressions using an adapted *lesson study* approach.

Transforming Mathematics Teaching with Digital Technologies: Key Ideas from the Literature

It is important to note from the outset that when using the word technology, I am not referring to general technology "hardware" such as interactive whiteboards, mobile 'phones, the internet or iPads, but to device agnostic digital environments that require the learner to engage and interact with mathematical ideas in very particular ways. Such environments may have been created within available mathematical software (i.e. dynamic geometry, dynamic graphing, spreadsheet or statistical software) or they may be embedded within a web-page or application. A general feature is that the environment is designed such that the users (learner and/or teacher) are required to change a mathematical variant and observe the resulting outputs such that they can construct a deeper mathematical understanding of how different mathematical ideas are dynamically related.

The example shown in Fig. 4.1 shows a task where students are required to edit either the graph (by dragging "hotspots") or the function (by varying the values of m or c in the general equation $y = mx + c$) so that the character in the simulation reaches a specified distance in a specified time, which is provided within the task narrative.

These teaching approaches are far from new and the research literature includes multiple findings that conclude positive impact on students' mathematical understandings (Borba & Confrey, 1996; Godwin & Sutherland, 2004; Hoyles, Kent, Noss, & Smart, 2012; Hoyles & Lagrange, 2009; Kaput, 1986; Romberg, Fennema,

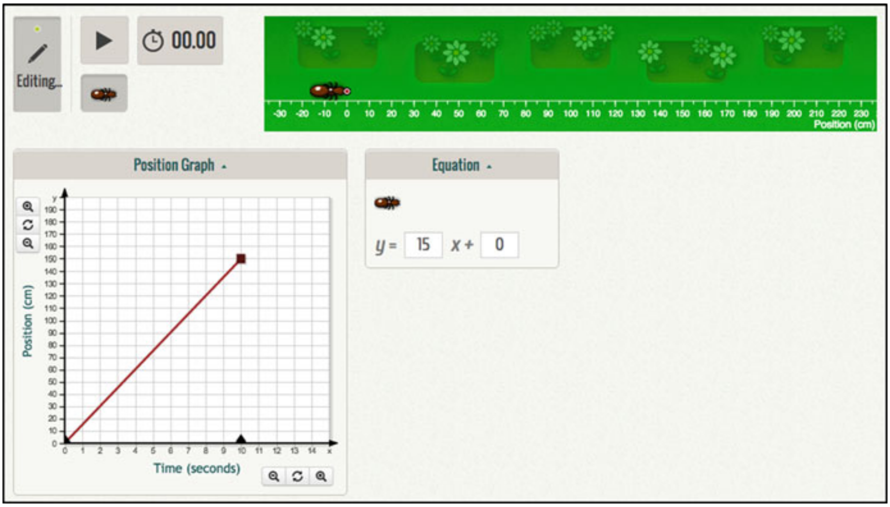

Fig. 4.1 Cornerstone Maths Software: Linear functions

& Carpenter, 1993). However, the proliferation of reports that conclude the weak impact of digital technology on students' learning outcomes (For example, see Organisation for Economic Co-operation and Development, 2015) would suggest that it is the choice of technology and the ways it is used with students that is key to replicating the positive findings of the research settings.

Within mathematics education, academics in the field of educational technology have shifted their research lenses onto teachers in an attempt to bridge the gap between research and practice and to deepen the understanding of teachers' trajectories in knowledge and practice as they learn to implement mathematical technologies such as those described previously (Clark-Wilson, Aldon, et al., 2014; Clark-Wilson, Robutti, & Sinclair, 2014; Zehetmeier, 2015). Such understandings could ensure more research-informed approaches to the design, implementation and evaluation of professional development that aims to develop knowledge and associated teaching practices.

The Development of Teachers' Knowledge and Practice Concerning Dynamic Mathematical Technologies

Early studies explored how students and teachers of high school mathematics learned to use mathematical technological tools both for themselves (instrumentation) and subsequently in their role as designers/implementers/users of classroom tasks (instrumentalisation). These drew from Vygotsky's activity theory and led to the "instrumental approach" (Artigue, 2002; Guin & Trouche, 1999; Haspekian, 2005; Verillon & Rabardel, 1995). More recent research has focused the lens onto

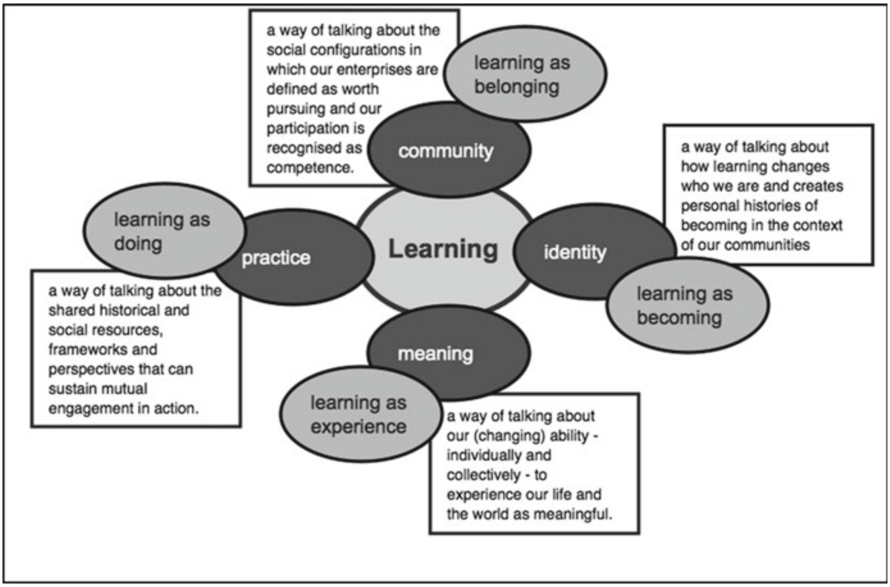

Fig. 4.2 Components of a social theory of learning (Wenger, 1998a, 1998b, p. 5)

teachers, resulting in the notions of epistemological "hiccups" (Clark-Wilson, 2010; Clark-Wilson & Noss, 2015) and "critical incidents" (Aldon, 2011) that occur during classroom practice as key triggers for teachers' cognitive learning. Consequently, the design of the CM teachers' professional development programme involved tasks for teachers that attempted to replicate these triggers, albeit in the less risky environment of a face-to-face PD session.

Designing Professional Development: A Community of Practice Perspective

According to Etienne Wenger's seminal work we all belong to multiple Communities of Practice (CoP) throughout our lives with varying levels of participation that impact differently on our learning (Wenger, 1998b). Wenger articulates how, in these communities, learning can be observed as the social construction of meanings within a community of practice, extending this notion and that of *situated learning* first described in the work of Lave (1988) and Lave and Wenger (1991). The components of Wenger's social theory of learning are shown in Fig. 4.2.

Central to Wenger's definition of a CoP is that it is a self-organising system that develops around things that matter to the members, even if the "raison d'être" for the CoP has been externally mandated. In such cases the members develop practices that respond to such mandates through their participation in the CoP. According to

Wenger, "a community of practice exists because it produces a shared practice as members engage in a collective process of learning." (Wenger, 1998a, p. 4). For the Cornerstone Maths project, the existence of the CoP is "legitimised" through the formal process whereby Headteachers register their school's involvement and commit to actions that seek to maximise the impact of the teachers' participation on students' learning outcomes. This legitimised relationship can bring the possibility that the participating teachers' actions might be scrutinised, over-managed or lead to new demands being made of them, for example, by being asked to "roll-out" CM in the school or to lead the professional development about CM to other colleagues within and even beyond the school.

In Wenger's terminology, the "joint enterprise" of the CM project CoP concerns:

- A common understanding of the work of the CoP, which is continually renegotiated by the members, i.e. the fundamental aim to provide opportunities for students to engage in mathematical activity that is mediated by the CM digital technology.
- Relationships of mutual engagement that bind the group together.
- The products of the CoP in the form of routines, ways of thinking, artefacts, vocabulary and ultimately, pedagogic styles.

Crucial to the design of the CM PD is that the members "develop among themselves their own understanding of what their practice is about" within the context of the CM approach to teaching and learning mathematics (Wenger, 1998a, p. 4).

Wenger describes the practices associated with his social theory of learning in relation to the participants' modes of belonging to the community of practice through their *engagement*, *imagination* and *alignment*. These are articulated further in Appendix and are used later in the paper to make sense of the findings of a particular group of project teachers.

A Methodology for Eliciting Teachers' Trajectories of Knowledge and Practice

The project recruited 72 teachers from 31 schools for the first PD cycle, which involved the following activities:

- Completion of an on-line questionnaire that collected contextual data and probed teachers' mathematical knowledge of algebraic variables and their prior use of dynamic technology in mathematics.
- Participation in an initial one-day face-to-face PD meeting, which included familiarisation with the CM curriculum unit, hands-on PD tasks with the CM software and collaborative lesson planning in school pairs within a shared space in an online project community.
- Participation in asynchronous follow-up support through the online project community and by email.

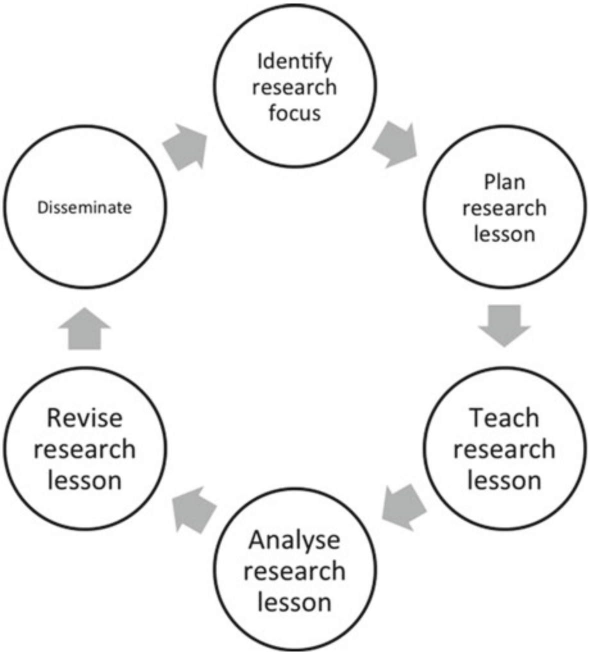

Fig. 4.3 The lesson study approach (Adapted from Foster et al., 2014)

- Participation in synchronous follow-up support provided by online meetings.
- [for a sample of teachers] Classroom observation of a CM lesson by the researcher, with pre- and post-lesson discussions.
- [for a sample of schools] Group observations of a CM lesson by the researcher and/or other members of the department, with pre- and post-lesson discussions.
- Participation in a final half-day face-to-face PD meeting.

We adapted a version of lesson study that had been developed for another Nuffield-funded research project in England, *Lessons for Mathematical Problem Solving* (Foster, Swan, & Wake, 2014) (Fig. 4.3).

The common research question that provided the focus for all of the teachers and researchers in the project as they created lesson plans to teach the research lesson was "to develop students' appreciation of an algebraic variable as a dynamic concept".

Our prior work had established the notion of "landmark" activities within CM, defined as those which

> indicate a rethinking of the mathematics or an extension of previously held ideas—the 'aha' moments that show surprise—and provide evidence of students' developing appreciation of the underlying concept (Clark-Wilson, Hoyles, & Noss, 2015).

Hence, all teachers planned to teach the same CM lesson and, although the CM curriculum unit does include outline lesson plans, we worked with the teachers to (re-)design the lesson to take account of their particular classroom contexts (student prior attainment, chosen technology etc.). The visibility of these "re-designs" was an important methodological tool that provided an insight into the aspects of the lesson that the teachers considered to need a greater or lesser emphasis and, in doing so, aspects of their knowledge and intended pedagogy. The subsequent sample of lesson observations, which were selected to give a diversity of teachers' prior mathematical and pedagogical knowledge/experience with dynamic technology in lower secondary classrooms, provided opportunities to probe teachers' developing knowledge and practices.

One Task: Four Lessons—Sixteen Stories

The case study of a group of four participating teachers from one school has been selected as an illustrative example of how their engagement with the project has impacted on their developing knowledge and practice within the very specific domain of the study. They all began with a plan to teach the same research lesson to a chosen class of 11–14-year-olds. All four teachers (Sasha, Darren, Nitesh and Cheryl) taught the lesson to their class, which was observed by the remaining three teachers.

The school, Greenfields High School, is a larger than average 11–18 secondary school in a relatively affluent area of Greater London that achieved examination outcomes in 2014 that are consistent with the national average. The mathematics department had 17 members and it was notable that the Head of Department chose to give four of the department the opportunity to participate in the project. One of the group, Sasha, was the co-ordinator of the 11–14 mathematics scheme for the department and all of the teachers were between 20 and 29 years of age with less than 5 years teaching experience. They all held first degrees in mathematical sciences and had completed post-graduate certificates in education. In their responses to the initial on-line survey, half of the group reported only occasional use of dynamic mathematical technologies by their lower secondary classes and the other two teachers reported no prior use. The teachers indicated that their barriers to such use were: a lack of knowledge of suitable technologies; a lack of time to explore possible technologies (either individually or with colleagues). Notably, a lack of access to suitable technology was not reported as a barrier.

In their research lesson plan, which was developed collaboratively during the initial face-to-face PD meeting, the teachers' "re-design" included the following aspects:

- Organisation of the technology and how students would be grouped.
- Key learning outcomes for students, which focused on an understanding that, within the dynamic representation, algebraic variables with the same name, behave in the same way.
- An opportunity to check that students were "instrumented" in their use of the software to enable them to achieve the mathematical outcomes of the lesson.

- Specific questions for the teacher to pose whilst demonstrating a particular counter-example.
- Consideration of how the students might respond to the lesson tasks—and some possible teacher reactions.

Supported by their Head of Department, whose authority enabled the teachers to be released from their own classroom teaching to each observe their three colleagues' research lessons, the group came together for a one hour meeting in their school to discuss the lesson outcomes. I observed and audio-recorded this meeting, in which each teacher began by giving their own recollection of their lesson in relation to the common research focus and, following this, the remaining teachers were invited to recount their observations. I intervened on occasion to clarify their descriptions and to probe the teachers' actions in more detail. As I was not present in any of the classrooms for the lessons, my questions were genuine as I sought to create a picture of the lesson.

Cheryl had been the first to teach the research lesson to a more-able set of 12–13-year-olds. Her overall reflection was that, although she concluded that the students had all achieved the desired learning outcome—that students could appreciate that when two mathematical variables have the same name (or are *linked*, using the terminology of the software), then they behave dynamically in the same way—she had over-structured the lesson, insisting on leading them through the software steps (the instrumentation phase) rather than allowing the students "enough freedom to explore it for themselves".

Cheryl continued to say,

> thinking about the linking especially, it didn't actually take too much nudging, if anything, I let too much slip on it, and they would have been able to do that on their own …
>
> … I thought they were going to find it a lot harder than they did, which I think is why I over-structured it—but if I was going to go back and do it again—it didn't need as much structures that, it could have been a lot more free.

Sasha agreed with Cheryl's evaluation, adding,

> I think we generally quite agreed as well after Cheryl's lesson that it was really good and that they'd all got to the place that we wanted to get to but that the main point was that they needed a bit more freedom, as Cheryl said, to kind of actually discover things for themselves, rather than being led.

I probed the teachers to try to find out what it was that the group felt that the students should have discovered for themselves and why this might be a more desirable outcome, to which Darren (addressing Cheryl) added his own observation,

> I think that you scaffolded it very well for them to have success and it wasn't just success but it was really meaningful success. So when they discovered linking they were really … they felt like they'd accomplished something and then that kind of slowly filtered down. I know I saw one pair who discovered it [linking algebraic variables] for themselves, 'oh if we name them the same it comes up with linking'—the pair next to them looked and said 'oh what have you done' and then they said 'oh what you do is you name them the same' …

The group reflected on the challenges of trying to remain a passive observer during the lesson observations but also appreciated the value of the knowledge that was gained when in this role. Nitesh commented,

> I was trying not to get involved too much and I think it was the hardest thing to see someone struggle and you just want to jump in to help … There were lots of conversations happening without Cheryl actually being there, which was nice, like in pairs and stuff. So it was nice to see. It was more the fact that, you didn't need to do anything—they figured it out for themselves.

Darren taught the lesson next. His experience of observing in Cheryl's classroom directly impacted on his own lesson plan as he gave his class much more time during his lesson to explore the software for themselves.

> I gave them too much freedom—towards around say the 35 to 45 minute mark I was starting to lose them because they had struggled for too long … On the first question, I didn't intervene early enough, I think I gave them too much freedom because there's two or three groups that were doing really really well and there was a couple of groups that were plodding on quite nicely, but there were three or four groups that were getting a bit frustrated with it and they were sort of quite hard to get back on side towards the end of the lesson … So when I saw Cheryl's lesson I gave them more freedom but I pushed it too far the other way. But from that we got a scale …

This observation was reiterated by the other teachers, who were highly supportive of Darren as his class, although slightly older (13–14 years), had lower levels of prior mathematical attainment and were less motivated than Cheryl's group. The general feeling was that due to the impending end of the lesson, Darren had rushed his final plenary, which was when he intended to discuss with the class why and how algebraic variables might need to be linked within the dynamic software—and in mathematics more generally.

The third lesson to be taught was by Sasha, who chose a class of 12–13-year-olds who were a lower attaining mathematics group, which was acknowledged by the other teachers to include a number of students with classroom behaviours that were challenging to manage. However, it was notable that two of the teachers had observed how two of these students achieved success in the lesson—and the role that Sasha had played in their achievement. Jason was particularly impressed by the way that Sasha had maintained the focus of the Pupil workbook, which contained the task instructions, during the lesson.

As the final teacher to teach the lesson, Nitesh, acknowledged that he had been at a distinct advantage as he benefited from the cumulative knowledge and experience of the group. He taught the research lesson to his class of 12–13-year-old students, who were of a slightly lower level of attainment than Sasha's class.

Cheryl commented that the lesson was well-structured, especially in the way that Nitesh integrated the opportunities for the students to record their findings in the Pupil workbook alongside their explorations with the dynamic software. Darren commented that the students in Nitesh's class seemed to value their work in their booklets more than his own class but more importantly, both Cheryl and Darren had acknowledged how it was Nitesh's actions in the classroom that had supported this particular outcome. Nitesh himself was impressed by the mathematical outcomes of his class, although he still felt that he could have had clearer expectations with respect to their written recordings.

Nitesh emphasised the use of the dynamic slider with his students as they checked whether the algebraic expressions they had created matched with the pattern and questioned how well his students had fully made sense of the expressions they had created, saying,

> Next time I do this, I'll focus on more about algebraic expressions and what they mean, as opposed to only creating the linked pattern.

The group was very positive about their overall experience within the cycle of planning, teaching and multiple observations and they all commented that they planned to teach the CM curriculum unit to another class.

Conclusions and Further Research

The mathematics department at Greenfields High School is already a CoP with established modes of belonging. The CM Project CoP began as a peripheral CoP to the four teachers as they began to engage in its activities and through their participation, assume aspects of its aims into their departmental practices. The teachers embraced the CM PD tasks, the collaborative research lesson planning task and most importantly, once they returned to school, the opportunity to engage in the lesson study cycle. In Wenger's terms, there was an appreciation of the *joint enterprise* of working to integrate student use of dynamic technology in their lower secondary lessons, the *mutual engagement* was noticeably established and, as the findings show, the emergence of a shared repertoire of dynamic technology use within the specified mathematical topic was beginning to emerge.

An important aspect of the teachers' development in their mathematical knowledge for teaching concerned their emerging mathematical vocabulary and the accompanying curriculum scripts that supported the classroom discourse alongside the dynamic technology. Although the software itself prompted the students to generate new language in the classroom as they "built" their algebraic patterns, "named" their algebraic variables and ultimately "linked" these variables, the teachers needed to think through what they would say as they made use of the software in both whole-class contexts and when supporting groups of students. By mutually observing each other it was very obvious that, by reflecting on their own approach, they could relate directly to the merits of another teacher's actions and their accompanying dialogue. The teachers also appreciated how, within these discourses, they needed to prioritise the language of the mathematics over that of the technology.

The teachers' engagement with the CM CoP was evidenced by their pursuit of the project's aims "in concert with others" through their "mutual engagement" in the project tasks. Their shared experiences, particularly within each others' classrooms, served to build their interpersonal relationships as well as open up peripheries of their own classroom experiences that had the potential to support them to develop new teaching practices.

A second facet to the development of teachers' mathematical knowledge for teaching concerns the way in which their imaginations enabled them to (re-)view their own practices alongside that of their colleagues and use their experiences to create their own visions for their own classroom practices with dynamic technology. The sharing of their stories of the classroom observations was fundamental to these processes as they imagined what their future versions of the research lesson might be. Much of their conversation was about seeing the students' mathematical behaviours in a new light. Darren spoke quite passionately about how seeing a particular student achieve highly during Sasha's lesson had prompted him to think about how he might adapt his teaching approach to engage more of his students. It was significant that all of the teachers planned to teach algebraic patterns and expressions using the CM curriculum unit in the future.

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Appendix: Learning Practices Within Wenger's Social Practice of Learning Model

Engagement

- definition of a common enterprise in the process of pursuing it in concert with others;
- mutual engagement in shared activities;
- the accumulation of a history of shared experiences;
- the production of a local regime of confidence;
- the development of interpersonal relationships;
- a sense of interacting trajectories that shape identities in relation to one another;
- the management of boundaries;
- the opening of peripheries that allow for various degrees of engagement.

Imagination

- recognising our experience in others, knowing what others are doing, being in someone else's shoes;
- defining a trajectory that connects what we are doing to an extended identity, seeing ourselves in new ways;

- locating our engagement in broader systems in time and space, conceiving
- sharing stories, explanations, descriptions;
- opening access to distant practices through excursions and fleeting contacts—visiting, talking, observing, meeting;
- assuming the meaningfulness of foreign artefacts and actions;
- creating models, reifying patterns, producing representational artefacts;
- documenting historical developments, events and transitions; reinterpreting histories and trajectories in new terms; using history to see the present as only one of many possibilities and the future as a number of possibilities;
- generating scenarios, exploring other ways of doing what we are doing, other possible worlds and other identities.

Alignment

- investing energy in a directed way and creating a focus to coordinate this investment of energy;
- negotiating perspectives, finding common ground;
- imposing one's view, using power and authority;
- convincing inspiring, uniting;
- defining broad visions and aspirations, proposing stories of identity;
- devising proceduralisation, quantification and control structures that are portable (i.e. usable across boundaries);
- walking boundaries, creating boundary practices, reconciling diverging perspectives.

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Chapter 5
Design-Based Research as Intelligent Experimentation: Towards Systematising the Conceptualisation, Development and Evaluation of Digital Learning in Schools

Tony Hall, Bonnie Thompson Long, Eilís Flanagan, Paul Flynn, and Jim Lenaghan

Abstract The interoperability, interactivity and mobility of technology create new opportunities and potential to enhance learning, teaching and assessment (e.g. Hall. Quest, 64(2): 105–115, 2012; Sharples et al. J Learn Sci, 24(2), 308–341, 2015; Flanagan. Digital ensemble: exploring the design of technology-enhanced learning to mobilise and augment students' engagement with English literature, 2015; Thompson Long and Hall, Aust J Educ Technol, 31(5), 572–596, 2015; Hall et al. Int J Mobile Blend Learn, 8(2), 2016). Importantly, the emergence of increasingly sophisticated digital devices and applications can potentially enable pupils to engage in learning that is more constructionist and interactive, where the predominant focus is on their being creative with technology (Robinson. RSA animate—Changing education paradigms, 2010; Resnick. Let's teach kids to code, 2012).

But how do we effectively design digital learning in schools, taking account of the rapid changes and innovations in educational technology and emerging, best educational practice and research? Moreover, how do we systematise this important activity, in order that it might serve to enhance digital learning in schools, through the alignment and synthesis of academic educational research and teacher professional practice? How do we intentionally effect educational change, informed by the exigencies of our practice contexts yet at the same time inspired by relevant philosophy and theory? One methodology that can help to enable and support this type of educational technology research and development is design-based research (DBR) (Reeves et al. J Comput High Educ, 16(2), 96–115, 2005).

This chapter explores concepts and principles of DBR in education, and how DBR—as a practitioner-oriented, interventionist methodology—can help with the systematisation of the design of digital learning in schools. After setting the context and outlining the contemporary challenges of technology-enhanced learning in educational contexts, the chapter discusses key features and principles of design-based

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research methodology. It outlines the main contributions and limitations of DBR, and how it might be applied—over time—to scale and optimise the impact of bespoke, principled design for digital learning in schools.

Keywords Design-based research (DBR) • Practitioner-oriented • Interventionist methodology • Technology-enhanced learning • Impact of design for digital learning in schools

Introduction: Characterising the Design Challenge of Digital Learning in Schools

Design is ubiquitous in education. From the earliest conceptions of curriculum in Ancient Greece to contemporary classroom teaching, the organisation and facilitation of learning in schools has entailed some notion and practice involving design: the philosophising, planning and implementation of an educational artefact, idea or innovation (Hanrahan, 2009).

Today, the challenge is how we can design our schools, classroom environments, technologies, curricula and other educational resources in ways that are practically impactful upon learning yet also guided and informed by cogent, contemporary educational concepts and theory (The Design-Based Research Collective, 2003).

In selecting a methodology for developing technology effectively for contemporary educational contexts and environments, there exists the imperative for a systematic approach. Importantly, the methodology adopted should help to address—in a principled and productive way—a number of key issues related to the empirical research question: how can we effectively design digital learning in schools?

The rationale for selecting a methodology for this purpose should primarily be its capacity to address what can be complex or intractable research challenges in schools and cognate educational contexts, formal and informal (Stevens, 2002). Education is highly situated; it is context dependent and sensitive (Lave & Wenger, 1991). Furthermore, how well do educational theories translate to, and directly inform educational practice? Is research that is undertaken in a highly specific or specialised context, generalisable and useful for other learners/settings?

Furthermore, there can be many different actors and factors that influence the design of innovation, educational technology and resultant outcomes (Heppell, 2016). Education and learning are complex and emergent processes, and a single theorisation may not always provide the broad kinds of insights required (Hall & Bannon, 2006). These are among the challenges we face in trying to innovate in education today, including through the integration and promotion of digital learning in schools.

Cited by Hoadley (2005), Dewey characterised the complexity and experimental nature of human experience well in this famous observation; and further to explaining the emergent nature of things, Dewey implied the importance of what we might term *intelligent experimentation* in the design of education as a profoundly human process:

> The conjunction of problematic and determinate characters in nature renders every existence, as well as every idea and human act, an experiment in fact, even though not in design. To be intelligently experimental is but to be conscious of this intersection of natural conditions so as to profit by it instead of being at its mercy. (Dewey, 1925, p. 63)

The goal of DBR is to approach this design challenge with systematicity and sympathy, that is: structuring a methodological approach that synthesises effectively the practice and theory of educational innovation and technology, while responding formatively to the practical, real concerns and goals of pupils, teachers, parents, and other educational stakeholders.

Before outlining the features of design-based research (DBR), and its potential efficacy in the design of technology-enhanced learning, we first set the context for our discussion by framing and outlining the challenges and complexity of contemporary education and educational technology design.

Design for the Challenge of Educational Complexity

The history of technology illustrates how design can be fortuitous—it can be difficult to predict or rationalise why one particular technology or design feature is ultimately adopted by users and proves successful. However, there are principles regarding successful design, which can help to ensure that a particular educational technology is useful to, and used by learners and teachers.

Successful innovations/technologies (more often than not) are created in a bespoke fashion for users—they are purposefully designed to be easy-to-use/usable (Norman, 1998).

People's expectations of technology and its usability have increased considerably in the last 20 years, and computer anxiety has been shown to be a significant contributing factor to teacher resistance to using technology (Butler & Corbeil, 2007; Gerard & Sleeth, 1996).

As a consequence, Gilbert (2002) advocated easy-to-use, *low threshold applications*, to encourage teachers to incorporate the use of information and communications technology (ICT) in their classrooms. Furthermore, effective design now seems to entail more than solely cognitive functionality or utility; users' affective or emotional connections to and through technology are important (Norman, 2005).

The Swiss educationist, Johann Pestalozzi considered *balance* an essential aspect of pedagogical design. He emphasised the need for learning to be "hands-on, minds-on and hearts-on" (Hall, 2011). In discussing contemporary education, Robinson (2010) highlighted the importance of *aesthetic experience*, where learners are interactively, sensorially engaged, especially in today's highly mediated and networked world, and what Robinson (2010) termed "the most intensely stimulating period in the history of the earth".

A further key aspect of education that we must also design for is the fundamentally social process (*zone of proximal development*) that undergirds all education, learning and teaching (Vygotsky, 1978).

In terms of ICT in education today, Cress, Stahl, Ludvigsen, and Law (2015) underscored the importance of designing computation to mediate and enhance collaborative learning. Stahl (2015, p. 15) noted how this entails: “looking at how groups of students interact with various technological artefacts and observing their meaning-making processes, their enacting of the technologies and their problem solving as mediated by the technologies”.

DBR, a participatory and iterative methodological approach that synthesises theoretical reflection with empirical experimentation, can afford us opportunities for deep and systematic analysis of the complex ecosystems of learners’ collaborative enactments of educational technologies.

A further issue which we must contend with as designers of educational technologies is the emergent nature of designing for complex educational settings like classrooms.

In laboratory studies the researcher typically identifies one or two hypotheses to test. However, this kind of research design may not characterise adequately the complexity of technology-enhanced learning interventions in modern schools and other educational environments.

In educational settings, there can be many complex factors, or multiple dependent variables affecting the success of innovative interventions for digital learning (Stevens, 2002; Stevens, Cherry, & Fournier, 2002). These factors can include, among others: learners’ developmental levels; the physical learning environment; collaboration and social interaction; narrative/storytelling; innovative, rapidly changing technology; and scaffolding/pedagogical strategy (Lingnau, Hoppe, & Mannhaupt, 2003; Luckin, Connolly, Plowman, & Airey, 2003; Marti et al., 2000; Stanton & Neale, 2003). Therefore, the method we choose for exploring and developing digital learning in schools should help with designing for the complexity of learners’ interactions in the naturalistic, real-world context of the classroom.

Design-based research can potentially provide an effective framework for designing digital learning in schools because, as a methodological heuristic, it endeavours to account for educational complexity. Barab and Squire (2004, p. 4) described how DBR “involves multiple dependent variables, including climate variables (e.g. collaboration among learners, available resources), outcome variables (e.g. learning of content, transfer), and system variables (e.g. dissemination, sustainability)”; and how it “focuses on characterising the situation in all its complexity, much of which is not now a priori.”

Design-based research is context-based and endeavours to improve an intervention or the use of a technology in the actual learning setting that is under study. This positions DBR in contrast with more limited, controlled experiments. Barab and Squire (2004) discussed how DBR may very well utilise laboratory-based experiments to highlight and further investigate a particular variable, but this will not define the approach. Collins, Joseph, and Bielaczyc (2004, p. 20) noted how: “In most psychological experiments there is one dependent variable, such as the number of items recalled or the percent correct on a test of some kind. In design experiments there are many dependent variables that matter."

Collins et al. (2004, p. 21) furthermore discussed how Professor Ann Brown (1992), (one of the pioneers of the design experiments/design-based research approach), valued laboratory studies but "going into complex settings" remained a principal concern: "Laboratory studies are effective for identifying effects of particular variables, but they often neglect variables critical to the success of any intervention. Ann Brown (1992) valued them for their role in developing a design, but to test and refine the design requires going into complex settings."

Therefore, design-based research can afford a systematic methodological context for conceptualising and implementing educational innovations, solutions and technologies that support learning as a complex and emergent ecosystem of dynamic and interactive, intrapersonal and intercultural interactions.

Supporting Emergent Design Through Cycles of Ideation and Intervention

Considering the complex and highly situated nature of learning across diverse contexts (Lave & Wenger, 1991; Stevens, 2002) the final outcome or result of educational technology research and development might not initially be evident/known, until it is trialled, tested and tweaked over time. This underscores the need for a flexible, iterative research framework, where one can begin with a cogent but revisable set of concerns and ideas, and as they arise in the course of deploying and evaluating digital learning in schools, explore emerging, insightful and promising design possibilities.

This is particularly important in studying digital learning in schools because an inflexible or more traditional evaluative framework, measuring learning through scores in written tests or the number of facts recalled, for example, will not sufficiently encompass the sorts of connectivity and creativity that learners can emergently experience through engaging with constructionist, digital learning. An adaptive framework, rather than an inflexible concept of learning in schools, can help to ensure that factors, integral to the enhancement of learners' experience with educational technology, are not overlooked or disregarded.

An additional issue that we must contend with as educational designers and technologists is that the history of computers in education is littered with hyperbole and unfulfilled promise about the potential of ICT in education and what technology can achieve in classrooms (Cuban, 2001). A systematic framework is therefore needed that enables us to establish—at an early stage—the merits of a particular innovation with digital learning in schools, and to see if further development of that technology is warranted.

The authors undertake their design-based research in a number of diverse educational contexts, including digital storytelling in teacher education (Thompson Long & Hall, 2015); technology-supported drama education for pupils' engagement

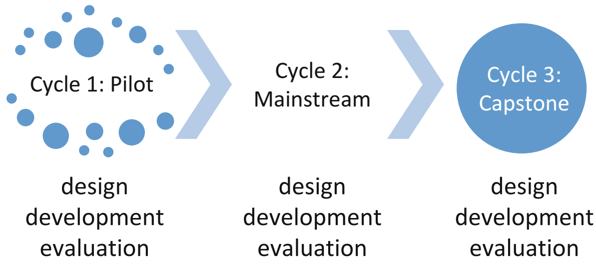

Fig. 5.1 Design-based research cycles: pilot, mainstream and capstone

with literature in schools (Flanagan, 2015); and designing enhanced history of education for communities of pre-service teachers (Flynn & Hall, 2015).

In the authors' design-based research exploring educational innovation across a number of contexts, the first intervention with technology-enhanced learning aims to establish the nascent potential of an innovation. We would contend that it is optimal if the design-based research process implementation can take place in closely interrelated cycles where changes and refinements to the design are systematically implemented and tested over at least three significant cycles: (1) pilot, (2) mainstream and (3) capstone. These cycles may develop along longer or shorter timelines, depending on what works best for the context, but we believe it is essential to have at least three cycles, where an innovation is trialled and tested—iteratively and rigorously—over time. Furthermore, involvement of learners and teachers as early as possible in, and throughout the process is of paramount importance, to ensure the design of digital learning unfolds in a systematic manner that is bespoke and useful for them as the most important stakeholders in the process. Figure 5.1 illustrates a suggested, overarching structure for undertaking design-based research along three, iterative cycles, each involving sub-cycles of design, development and evaluation.

Each cycle prefigures and informs the ensuing cycle. At the end of the third, capstone intervention and evaluation of the innovation, the design may still only be at a formative stage of development. Indeed, as Hoadley (2006) has suggested, our design of educational innovation may always be ongoing, formative rather than summative, changing depending on the local exigencies of the given educational context.

Adoptable and Adaptable Design Models: Synthesising Practice and Theory

Integrating novel computing in the design of digital learning in schools complexifies the research challenge: "the sophistication of our technologies—in the new and hybrid practices they make *possible*—far outpaces the sophistication of our analyses" (Stevens, 2002, p. 271). A significant potential advantage of design-based research is that it can enable us to explore complex technology-enhanced learning innovations in a systematic, informed and emergent way (Barab & Squire, 2004).

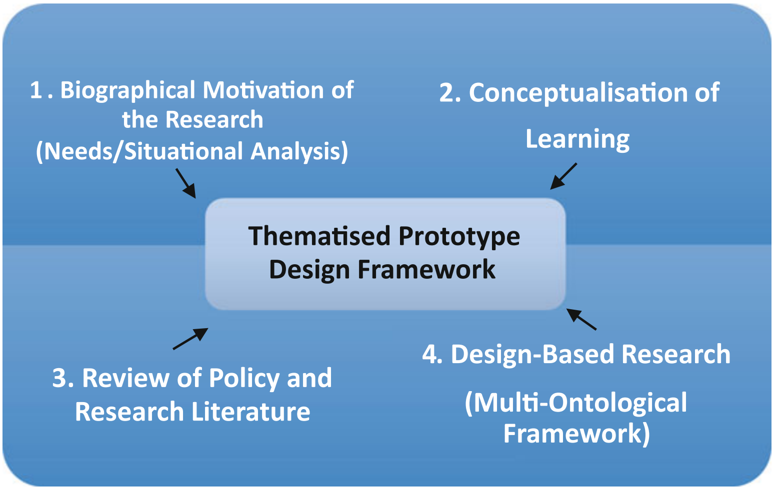

Fig. 5.2 Emergence of early design framework

The methodological approach adopted in designing digital learning in schools must try to align practice and theory closely. It should be well-informed, from an ontological or theoretical perspective, but also sensitive and adaptable to the local complexities and issues affecting schools and the use of novel digital learning technology within them. Stevens notes how traditional and inflexible approaches, where practice is detached from theory, have historically created problematical constraints within educational technology design research: “We have inherited divisions of academic labour among assessment, technology, curriculum, and close studies of practice; what we seem to need now is articulation work that draws these pieces together (remaking each in unexpected ways no doubt)” (Stevens, 2002, p. 272).

In the authors’ experience, the initial ideation stage of design-based research typically involves the synthesis a number of key activities. Figure 5.2 illustrates the four main activities that normatively inform the *articulation work* for the nascent design-based research model.

The aim at this incipient stage is to produce an initial prototype model to guide and test the efficacy of a first pilot intervention of the design-based research process. The initial framework will typically be composed of a number of central design themes. Certain themes may appear more regularly in design-based research models. We consider the reason for certain themes, such as narrative and collaboration, appearing more frequently in DBR models and frameworks would be as a result of their commonplace, universal importance in education and educational technology design. For example, narrative/storytelling and collaboration/social interaction constitute fundamentally important, communicative and creative foundations of learning and teaching in general (Bruner, 2002; Egan, 1986; Vygotsky, 1978).

The background and biographical motivation of the researcher(s) is critically important. This may emerge from needs or situational analysis in school—the identification of a problem to be fixed or a challenge or opportunity to innovate. The second component: conceptualisation of learning is crucially important as it helps to ensure that the most effective educational approach is being adopted and followed. As in all research, review of the extant, relevant literature is essential, helping the design researcher to see how other, cognate technology-enhanced learning interventions have been designed, deployed and evaluated.

DBR can help us to address a wider set of variables than is the case in normative laboratory study. However, to understand these variables comprehensively and cogently, it might be necessary to draw on multiple theoretical perspectives and a diverse range of educational concepts and philosophies. This is where the fourth aspect of the initial prototyping, the definition of a multi-ontological framework, becomes particularly important/useful. Engagement with a broad set of concepts and theories is encouraged in design-based research as it can help us to understand expansively complex educational design problems or questions.

Each of the design cycles cumulatively contributes to the articulation of the overall design based research process. The first cycle—typically a pilot implementation of a nascent technology design, predicated on the nascent framework or *prototheory* (The Design-Based Research Collective, 2003)—demonstrates and establishes the potential of an innovation or technology. This is very important as the impact or potential of a technology or innovation can remain unrealised, unclear, "unproven". Design experiments, especially through prototypes and early, smaller-scale exploratory interventions can help us to understand a technology or innovation better. The initial deployment and evaluation of digital learning can also help to establish whether or not the idea or innovation merits being continued and scaled up.

Subsequently, once the pilot has been implemented and evaluated successfully, the mainstream implementation starts to enumerate in detail how an innovation or technology can be used to enhance learning. The mainstream cycle(s) shows how the initial intervention might be extended and expanded over time, which widens the scope of the innovation or technology's potential impact. Furthermore, this key cycle contributes to our understanding of how educational innovation or technology can be designed, deployed and evaluated on a more longitudinal basis.

The final capstone cycle or intervention is crucially important in helping to verify the design-based research process overall. This summative stage in the DBR illustrates a design model or framework that others can use (adapt and adopt). To an extent, it finesses and validates, by the end of the final design and evaluation cycle, the overall development and elaboration of the design approach, contributing a model: set of criteria or *design sensitivities* (Ciolfi & Bannon, 2003) that design researchers and educational technologists can adopt and adapt, in endeavouring to achieve the same impacts and benefits of the innovation/technology, (or similar), in their respective educational settings.

While practice is a core part of design-based research, there exists the imperative for an orienting set of design themes or ontology, both to guide and validate practical, empirical activities. Theorisation and experimentation interleave and evolve

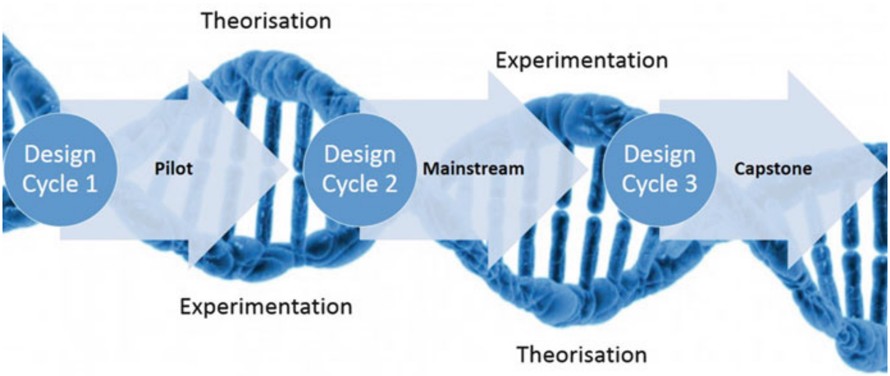

Fig. 5.3 Experimentation-theorisation: The DNA of design-based research

concurrently, throughout the design-based research cycles: from pilot, through mainstream, to capstone. In education, as Langeveld wrote: "theory without practice is for geniuses, practice without theory is for fools and rogues, but for the majority of educators the intimate and unbreakable union of both is necessary" (Morrison & van der Werf, 2012, p. 399). Figure 5.3 illustrates the essential, intrinsic importance of practice and theory, *experimentation-theorisation* in design-based research.

Furthermore, as diSessa and Cobb argued, the theory that is used must have utility for the design practice: "Theory must do real design work in generating, selecting and validating design alternatives at the level at which they are consequential for learning." (2004, p. 80) The end-result of an effective design-based research process typically is the synthesis of practice and theory—their successful embodiment in the final intervention: "the intervention as enacted is a product of the context in which it is implemented, the intervention is the outcome (or at least an outcome) in an important sense." (The Design-Based Research Collective, 2003, p. 5)

Furthermore, the intervention illustrates and supports the enumeration of design guidelines, models or sensitivities that can be adopted and adapted by other researchers and practitioners in the field (Collins et al., 2004; The Design-Based Research Collective, 2003).

Potential Limitations of Design-Based Research

Design-Based Research is a form of evidence- or practice-based research. DBR can trace its origins to action research (AR), and although the two are closely related (Anderson & Shattuck, 2012), AR does not look specifically at design.

> Although action research certainly has merit, there is much more potential value in design research, because it combines seeking practical solutions to classroom problems with the search for design knowledge that others may apply (Reeves, Herrington, & Oliver, 2005, p. 107).

One of the criticisms of practitioner-oriented research is that the immediate, subjective involvement of the researcher in the design process may mean that the outcomes will be biased. However, as McNiff, Lomax, and Whitehead noted, “Taking a critical stance towards your action and its outcomes is an essential piece of coming to an explanation/‘being subjective’ can be both an advantage and a limitation” (2003, p. 25). They identified three levels for corroborating one’s findings, in order to enhance the robustness of practitioner-based research, including verification through *self*, *peer* and *wider public validation*.

In design-based research, validity is addressed through the cycles and iterations of technical development, field studies and design consultations with key stakeholders in the learning context: pupils, teachers, principals, etc. The Design-Based Research Collective advocated this kind of triangulation of data as a means to validate results derived from design interventions: “design-based research typically triangulates multiple sources and kinds of data to connect intended and unintended outcomes to processes of enactment. In our view, methods that document processes of enactment provide critical evidence to establish warrants for claims about why outcomes occurred.” (2003, p. 7) The close interplay of theorisation and experimentation in design-based research can help to enhance the robustness of the design as it iterates through the cycles of design, development and evaluation: from pilot, through mainstream, to capstone.

There are however some challenges in detailed design-based research and evaluation. Detailed triangulated evaluation can result in very significant corpuses of data, which can be difficult to parse and analyse, and as Hoadley (2006) suggested, the final design model is typically never “final”—it always remains a prototype model, in need of continued/further adaption and improvement/refinement. Importantly, however, DBR can help to establish the potential of an innovation and illustrate for the research community how the approach might be deployed over time to enhance learning/education.

While ethnographic approaches can provide excellent research methodologies to describe and document the effects of digital learning in schools, design-based research is distinct in that there is a commitment in DBR to change and improve design practice. This is critically important from the perspective of designing digital learning in schools, where the endeavour is to refine practical designs and build effective educational interventions: “In general, ethnographic research attempts to characterise relationships and events that occur in different educational settings. There is no attempt to change educational practice, as in design experiments.” (Collins et al., 2004, p. 21)

The authors recommend using design-based research with ethnographic approaches because “ethnographic research produces rich descriptions that make it possible to understand what is happening and why.” (Collins et al., 2004, p. 21) Furthermore, critical summative evaluation of a design is to be recommended, particularly where one is validating a final intervention, as the basis for generating an integrated design model or series of design sensitivities.

As a methodology, DBR is especially apropos in respect of designing digital learning in schools. It can help us to integrate/synergise practice and theory.

Moreover, DBR can help to support broader conceptualisations of educational problems and questions, drawing on different theoretical perspectives to offer multi-ontological frameworks that expand our units of analysis to engage with the multiple dependent variables that characterise the complexity of education in context. DBR can also support constructive learning from experience, especially where something novel is being tried; systematicity is needed in innovative initiatives with digital learning in schools.

Conclusion

Situating our approach to DBR in the context of the McKenney and Reeves (2012) model for educational design research, there are normatively four major outputs from the multi-cycle approach we recommend. diSessa and Cobb (2004, p. 80) noted the tension between impactful local designs for learning, and generalisation and theorisation beyond the immediate educational context: "When working in the multifaceted or even seemingly chaotic settings in which design studies are conducted, one must have some orientation on central versus peripheral concerns, and one must be very clear on what general results are intended." They furthermore highlighted the importance of addressing local exigencies, while concurrently remaining ontologically rigorous in our attempts to understand and change the "apparent complexity and messiness of human action and learning". For diSessa & Cobb, "The central problem/is that of how best to pursue theoretical agendas, befitting what we believe we know so far and acknowledging whatever special circumstances are our lot in education-related sciences." (diSessa & Cobb, 2004, p. 80)

In the McKenney and Reeves (2012) model, there are two primary contributions of educational design research: *proximal* and *distal*. Proximal relates to the local context and the impact of the innovation on learners and teachers in the near (or *proximal*) setting. *Distal* refers to the generic or generalizable outcomes of the design process—the design criteria, guidelines and sensitivities.

Overlaying our multi-cycle design-based research process on McKenney and Reeves (2012) generic model, Fig. 5.4 illustrates the emergence of our design models and sensitivities, and the general, related outputs we aim for over at least three significant design cycles. We would also contend that there is a middle or *medial* contribution—between the distal and proximal outputs of educational design research. These intermediary resources include artefacts such as timetables, software, assessment/evaluation rubrics, and so forth. They are connective resources—linking the general, ontological design criteria or guidelines with the local, situated deployment of the innovation.

As illustrated in Fig. 5.4, in our design-based research, we work towards a mature intervention in the local educational context, where the aim is to initiate and sustain an innovation which supports and promotes students' engagement in creative, constructionist learning. The primary output of our research locally is the enumeration of a cyclical, iterative process of design which demonstrates how a particular innovation can be piloted, scaled up and developed.

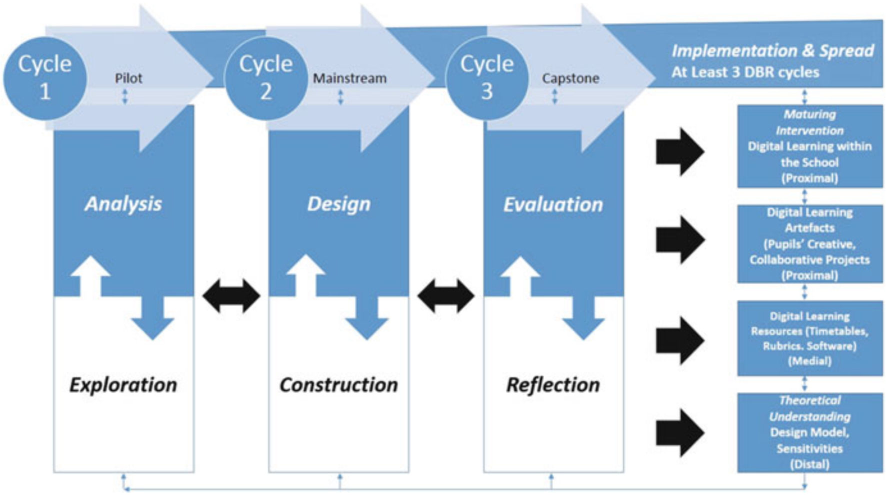

Fig. 5.4 Outputs from multi-cycle design-based research (adapted from and based on McKenney & Reeves, 2012 generic, integrative model for educational design research)

Further, key local outputs of our work are exemplars of digital artefacts created by learners through their engagement as the key participants in the DBR process. These are as important as the maturing intervention in context; the quality of the work learners produce is a critical data-point and of paramount importance in evidencing the efficacy and success of the innovation, or not.

The third and fourth significant contributions are the resources (timetables, rubrics, software), and the design model: criteria, guidelines and sensitivities, which other design-based researchers and educational technologists can adapt and deploy to support and develop innovative learning within their own context.

To address the complex, practical research challenge of designing digital learning in schools, an approach inspired by design-based research concepts and methods has much to commend it. The recursive intervention cycles afforded within DBR can enable practice and theory to augment each other. Further, the multi-ontological frameworks we typically use in DBR can enable us to characterise learning closer to its essential complexity. DBR can also enable us to remain responsive to the emergent, experimental nature of things through adaptability and flexibility in methodological orientations. DBR results in reusable exemplar processes (interventions) and products (models), and frameworks for design, analysis and evaluation. Undertaken over at least three iterative cycles, DBR can afford a ternary of important, useful contributions: (1) proof-of-concept, (2) longitudinal illustrations of digital learning in action and (3) repurposable design models.

Barab and Squire (2004, p. 2) described how DBR, as an emerging paradigm of educational inquiry, is becoming very useful and thus more widespread as a transformative approach in education. Further, they emphasised the importance of design-based research as a means of introducing systematicity into how we conceptualise, develop and evaluate our educational technology designs and innovations:

> The commitment to examining learning in naturalistic contexts, many of which are designed and systematically changed by the researcher, necessitates the development of a methodological toolkit for deriving evidence-based claims from these contexts. One such methodology that has grown in application is that of design experimentation or design-based research (Barab & Squire, 2004, p. 2).

Design-based research can help us to address the complex research challenge of how we design digital learning in schools. It can assist us in improving our local design practices and technology-enhanced learning interventions in classrooms and other educational settings. Furthermore, DBR can support us in generating design guidelines, which other educational designers and technologists can adopt and adapt to develop innovative digital learning that enhances pupils' educational experiences and outcomes in their respective, unique schools.

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Chapter 6
Images of Educational Practice: How School Websites Represent Digital Learning

Charles Crook and Natasa Lackovic

Abstract What does school life and learning *look* like? One way of addressing this question would be to consider the images that educational institutions employ to represent the activity of their students. In this chapter, we report the results of applying such an approach to 151 websites of English primary schools. They were randomly selected from a government database of such schools. Photographic images found on these sites were then classified into 18 base categories according to their principle content. Images of the school 'environment' (the building, classroom), 'sport' activities and 'personality' images of children (presenting individual or groups of children) dominated this corpus. The principle themes tended to show children variously involved in exercise, performance, visits to external sites or different forms of active inquiry. Involvement with any type of digital resources was found to be a very infrequently represented form of student activity. This low profile of digital engagements was reinforced by an audit of after-school clubs advertised on the websites which showed that less than 5 % of the clubs were technology-related. These findings are discussed in terms of a tension between the rhetoric and investment associated with technology-enhanced learning and the extent to which it is publically and visually celebrated by educational institutions.

Keywords School websites • Digital learning • Digital culture • Primary schools • Market-oriented • Environment • Schooling • Pupil invention • Creativity • Connected • Digital tools • School App • Student experience • Digital learning

Introduction: The Imperative of Digital Learning

A failing system of education is often invoked when societies are reflecting on their various troubles and disorder or, most commonly perhaps, their sluggish growth into prosperity. Formal schooling has weathered a history of social criticism—from

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Dewey (1929) through Freire (1986) and Illich (1971) to the engaging challenges of high-profile commentators such as Lord Puttnam[1] and Sir Ken Robinson (2006). When it then comes to addressing how educational practice might be repaired or reinvented, it is not surprising that, right now, there is much interest in the juggernaut of digital technology.

There have been various arguments that converge on the imperative for schools to embrace this technology. First, it is clear that digital media is ubiquitous. It pervades a wide range of representational, expressive and interpersonal cultural practices. Many routine but important transactions of everyday life are now mediated by this technology (shopping, job applications, personal accounting etc.). Therefore, actively cultivating media literacy in early life must seem a priority. A related and second argument for schooled confidence with digital media arises from the growing political focus on student employability. Often a misalignment is identified between the toolsets of employment and the toolsets of education (e.g. Fuller & Joynes, 2015). It is because "knowledge work" (Solow, 1994) has become so central within the pervasive "knowledge economy" (Drucker, 1992; Lundvall, 1992) that there has grown a pressure on schools to have students embrace new technology as a solid foundation for work. This pressure comes from both employers and politicians. For instance, former UK Education Secretary Michael Gove commented in a keynote speech: "Our school system has not prepared children for this new world. Millions have left school over the past decade without even the basics they need for a decent job. And the current curriculum cannot prepare British students to work at the very forefront of technological change" (Gove, 2012). However, the status of technology in everyday school life remains poorly understood—as does the extent of any "digital divide" between schools.

Michael Gove's speech introduced a new UK curriculum requirement. One that required students to engage with computer coding from 5 years of age and onward—a significant challenge for early education practitioners (Brown, Sentance, Crick, & Humphreys, 2014). This initiative not only identified a significant response to concerns about preparing students for technology-rich workplaces, it also signalled a belief that acquiring creative confidence with digital tools empowered young people's imagination and invention: "By its very nature, new technology is a disruptive force. It innovates, and invents; it flattens hierarchies, and encourages creativity and fresh thinking" (op. cit.). Of course learning is typically a creative commitment and this "tool-of-creativity" vision of technology can be coupled with a more familiar "tool-for-learning" approach. All of the major theories of learning within Psychology have each embraced the potential of digital technology to support cognitive development. From behaviourism (Skinner, 1965) through constructivism (Papert, 1980), into socio-cultural theory (Crook, 1994) and cognitive science (Lajoie & Derry, 1993): all the major theories of learning have offered manifestos for the transformative potential of these tools when suitably embedded in educational contexts.

Finally, there is an imperative for technology in schools arising from a faith in the idea that these tools must have a potential to *motivate* learning. This is claimed in

[1] http://www.davidputtnam.com/education.

response to the conspicuous appeal of these technologies for young people: albeit an appetite that is sometimes celebrated (Prensky, 2001) and sometimes regretted (Palmer, 2015)—with all such judgements still being hotly contested. The simple refrain that rises above such controversies is that if these so-called "digital natives" are so comfortable (and inventive) in their recreational application of the technology, then we must design activities that recruit its appeal into more classroom applications. This observation and the others made above converge on the expectation that digital learning is being actively cultivated in even the earliest years of education.

This chapter only investigates the reality of such expectations in the UK and only in the primary sector of education. However, international surveys suggest educational policy, practice and outcomes in the UK do not depart strongly from, for example, European norms (OECD, 2015). In terms of investment, the expectation of a strong digital presence in schools certainly seems well met. Investment began in earnest in 1999 when a "New Opportunities Fund" of £230 m was used to provide ICT training for teachers. Curriculum Online was launched in 2001 involving £50 m of e-learning credits. In 2003 this was increased to £230 m over 3 years. This was followed by a £100 m "Laptops for teachers" initiative and in 2008 a "Harnessing Technology Grant" provided £639 m to help schools and their local authorities improve such services as broadband infrastructures and learning platforms. Moreover, investment continues to grow. BESA (the trade association of British educational suppliers) report a 2013 survey involving over 700 primary schools: these schools predict that their expenditure on ICT in 2014–2015 will be higher than any other time on record.[2]

Taken together, the observations above assemble into a strong expectation of vigorous ICT-mediated activity in primary schools. Politicians, employers, and learning theorists voice encouragements for this direction of travel. Moreover, the distribution of government funding into this area must mean that digital tools have simply been the major form of (non-staff) learning resource investment for the school system. Yet it must be acknowledged that, despite these apparent imperatives and these generous investments, commentators have often diagnosed a very slow pace of adoption and change in relation to digital learning (e.g. Livingstone, 2012).

There are grounds for caution in how such concerns are interpreted. Their diagnoses tend to be based on outcome studies and these often dwell on merely relating attainment to simple (digital) resource counting. Moreover, some commonly cited studies linking ICT adoption with attainment in this way need to be refreshed for present circumstances (e.g. Harrison et al., 2003). In terms of method, many of them are based on self-reporting surveys some of which, again, need to be updated (Selwyn, Potter, & Cranmer, 2008). While others make coarse grained observations that may conceal telling diversity. For instance a recent cross-national attainment survey (OECD, 2015) builds its sceptical conclusions on interrogating computer use but it fails to define "computer" in its questionnaires (p. 47). This surely would have left respondents uncertain about the status and use of such digital resources as

[2] *ICT in UK State Schools*. Retrieved October 30, 2015, from http://www.besa.org.uk/news/besa-press-release-besa-releases-ict-uk-state-schools-research.

whiteboards, smartphones, e-readers and tablets. There is certainly a lack of more ethnographic and longitudinal studies of technology use in schools—studies that might identify patterns and modes of teaching and learning practice rather than simply access to resources. The reports of government inspectors, while hardly ethnographic, do involve close observations and they tend to diagnose a slow and fragmented style of adoption (Ofsted, 2009).

The Website as Window into School Life

Outcome studies (relatively common) and large-scale classroom observations (relatively rare) are just two windows onto the digital culture of schools. In this report we consider a different kind of window: namely, the school website. It is less often considered yet it is one that might provide a different and distinctive snapshot of how digital resources are embedded in typical school life. So we are considering here how digital learning and communication are projected as photographs on school web pages. For a focus of that kind there clearly is a dimension of national context—government, custom and practice may dictate different expectations and approaches to what is published in such places. In the case of the UK there is, first of all, an expectation that primary schools should all have a website. Moreover, there are then clear guidelines as to what schools must publish online—somewhere.[3] In particular, they must make visible various documents and reports relating to curriculum delivery, performance, behaviour and arrangements for admissions. They must also detail various policies on expenditure of government income and make a statement of institutional vision and ethos. One way in which the national inspection agency (Ofsted) will determine if these requirements are being met is by making a visit to an institution's website. This has made such sites much more significant for schools. Previous advice was little more specific than the tentative suggestion that: "Parents could see more about what their children are learning in school through a school's website" (Becta, 2008, p. 5).

In addition to their role in quality management and accountability, websites have therefore become very effective ways to reach out to parents (Laffier & Laffier, 2014; Piper, 2012). One group of researchers in Australia scrutinised such sites and suggested criteria that schools might work to in order to achieve an attractive and effective presence (Taddeo & Barnes, 2016). Cultivating such aspirations has meant that schools no longer depend on an enthusiastic classroom teacher to define their presence: guidance and production is more likely to be entrusted to professional website designers.

While parents of students in a school are one significant audience for this presence, websites are not for them alone. These sites are also reaching out to another constituency: namely, those families who will be *future* users of the school. In an

[3] *What maintained schools must publish online - Detailed guidance*. Retrieved October 30, 2015, from https://www.gov.uk/guidance/what-maintained-schools-must-publish-online.

increasingly competitive atmosphere of school choice, the marketisation and commodification of school is apparent. Web designers are stressing the importance of this marketing role to their school clients. As one company puts it: "We recognise that the job of marketing a school has changed dramatically over the last 5 years. Technology continues to drive an ever-growing expectation amongst parents".[4] While another closes the gap between schools and the marketing of more familiar consumer products: "Schools can use marketing techniques to give parents confidence in where they are sending their children. This can be achieved through utilising the school website and local publications to spread good student news—it all enhances the value of a local school as a brand".[5] In short, it is likely that many schools accept how: "A professional, interactive website could make all the difference when parents are deciding where to educate their children".[6]

Others have considered how the rhetorical strategies applied to school prospectuses and brochures work for schools to manage the necessary modern discourses of identity, success and privilege. However, such analysis is traditionally applied to the *text* of these documents (cf. McDonald, Pini, & Mayes, 2012), rather than any other expressive modality they employ. In this chapter we wish to give more attention to the use of *visual* representations—photographs—when constructing meaning on these websites. There are good reasons for this decision. The recent prescriptions of institutional inspection have rendered school websites rather bureaucratic in format—heavy on standard text at the expense of content that asserts individual identity. The browsing viewer of these sites is surely more likely to be engaged by the photographs and thereby take from them a strong sense of the culture and everyday life of a school. Arguably, this has become the main device whereby a school can project the distinctive character of its activity.

Therefore, in diagnosing the digital culture of early education represented through the "window" of school websites we shall:

- First, characterise the student experience as manifest in published photographs of school activity. What is of special interest is the extent and representation of digital learning in these photographs.
- Second, we will consider how far children's digital work is celebrated through its publication in this school medium.
- Third, we will consider the site as itself a digital tool for communication and ask how far schools are using the design features of web pages to create a vivid and engaging encounter with their audiences.
- Fourth, we will consider a further form of school practice identified on these sites—one that also sits outside of statutory required information—namely, reference to extra-curricular activity and clubs and, in particular, the visibility of digital interests as a theme within those activities.

[4] Retrieved October 30, 2015, from http://www.schoolwebsite.co.uk/.

[5] Retrieved October 30, 2015, from http://www.greenschoolsonline.co.uk/services/school-branding/.

[6] Retrieved October 30, 2015, from http://www.phenixeducation.co.uk/website-design/.

Therefore in the remainder of this chapter we describe our findings from analysing a significant sample of UK primary schools in relation to the above four themes. In the next section our method is outlined, this is followed by a summary of results and, finally, some consideration of their implications.

Sampling School Websites

The UK government publishes a list of all schools in England. In order to create a sample for investigation, we selected the website URL for every 100th "primary school" in that list. This provided a 1 % sample, or 167 schools. For reasons that are not clear in relation to the construction of this official list, there were a number of schools with repeated entry and other that had apparently closed. These were excluded, leaving a sample of 151. In cases where a URL was not given, the next available published URL in the list after that school was used as a replacement.

Two coders (the authors) independently considered a selection of sites in order to negotiate a set of thematic categories that would allow a confident content analysis of the photographic images found on these sites. Such coding involves attaching interpretative codes to individual photographs in order that a quantitative summary can then convey the "landscape" of representational practice.

The 12 resulting codes are shown in Table 6.1 along with their definitions.

Table 6.2 gives further example photographic content for each category. The principle problem encountered was the practice of schools presenting "sets" of photographs depicting modest variants of the same event. For example, if a class is doing dressing-up role play then it is probably judged appropriate to publish a photograph of every student involved in this activity. Similarly, a football match might be photographed repeatedly to share highlights. When encountering these sets, we coded the images as a single case. Also, when it comes to the category "our work", we coded the variety of photographed artefacts rather than counting every individual image (a particular poster, a particular art style etc.). Otherwise, presenting category counts would inflate activities that naturally invite equitable representation of participants or that demand multiple perspectives on the same content. Therefore the findings reported here might be considered a snapshot of content "themes". It seems like that users of a website would themselves construct meaning from images in this way—particularly as these "sets" were often embedded in slide shows with a single cover image to the set which needed then to be opened.

Sites were often generous in their use of photographs. In one case the number was so large (thousands) that it was decided to randomly sample the content of each page. On the other hand, every site had at least some photographs. Other coding practice was as follows. Archived material was not considered, only that which was current. Neither were photographs considered that might be concealed within documents such as Word files or PDFs to be downloaded. Although in principle it is possible for a single photograph to depict multiple themes, we did not experience tensions of this kind in practice. It is likely that published photographs were conceived with a clear

Table 6.1 Codebook for content categories applied to images, highlighting the category of particular interest here

Category	Definition
Exercise	Showing children in sport or other physical activity, alone or in a group
Personality	Individual children or groups addressing camera directly
Performance	Performing through role playing, simulations, dance or dressing up
Music	Individuals or group making music (playing instruments or singing)
Site visit	Out of school, exploring a structured environment, exhibition, or event
Visitor	Sharing experience of individual visitor or representatives of community service
Fieldwork	Collecting or scrutinising material or nature in a place outside school bounds
Environment	Highlighting the space or material resources of the school
Reading	Engaged with text, alone or with others
Discussing	Peer conversation located in some school learning space
Teaching	Teacher addressing individual student or group in structured encounter
Inquiry	Manipulation of materials or symbols for problem solving or investigation
Computing	Interacting with some item of digital technology
Making	Manipulating materials in order to construct artefact or representation
My work	Student displaying personal work to camera
Our work	Group presentation of own work, or direct images of that group artefact work
Other school	Relationship with other school
Metaphor	Representing something other than its content (pictures symbolising something)

understanding of what themes they were illustrating. In short, it was not felt difficult to read intended meanings associated with these images.

The sites were also scrutinised for a number of other issues relating to digital learning. In particular, the following questions were asked.

1. **Clubs**. Does the site indicate the existence of extra-curricular school "clubs" or interest groups? If so, what were they and did they include digital learning or interests. These informal school groups were categorised in the following way (Table 6.3).
2. **Digital artefacts**. Does the site publish examples of student work created with digital tools? Evidently a web page is a perfect location to share such student creativity and invention. We therefore looked for (and counted) examples of student video, sound recordings, graphic designs and animations.

Table 6.2 Example cases for the content categories applied to images, highlighting the category of partcular interest here

Category	Examples of depictions
Exercise	Gym, race, football, skipping, playground game
Personality	Class photo, posed moment within ongoing activity, smiling children portraits
Performance	School play, costume posing, adopting a role, dancing
Music	Instrument practice, choir, concerts, drum session
Site visit	Museums, galleries, worksites, cultural institutions, special "Day" at school
Visitor	Distinguished person, discipline expert, local fire service
Fieldwork	Collecting flowers, collecting weather data
Environment	Empty school spaces, lab equipment, materials, pets, school garden
Reading	Solitary attention to book, group work with books in book corner
Discussing	At-desk debate, pair conversing at shared material
Teaching	One-to-one encounter with teacher, teacher addressing class
Inquiry	Science lab, doing calculations in maths
Computing	Controlling robots, writing on interactive whiteboard, using a tablet, computer
Making	Making pictures, building models
My work	Holding up painting, presenting finished model
Our work	Classroom displays, collections of constructions
Other school	Activities at partner school
Metaphor	Symbolic representation of some goal or virtue

Table 6.3 Codebook for identifying variety of extra-curricular categories of club activities

Category	Exemplar definition	Example
Sport	Team games or personal exercise	Football, yoga, gymnastics
Hobby	Cultivating craft or skill of sedentary game	Sewing, cooking, chess
Music	Practising individually or group	Choir, orchestra, guitar
Performance	Group rehearsal or personal skill mastery	Dance, school play
Art	Representing in traditional media	Painting, sculpture
Academic	Curriculum subjects	Maths, history
Computer	Any reference to using digital tools	Coding club, ICT
Language	Foreign languages	French, Mandarin
Homework	General studying support	Homework club
Film	Cinema material or topics	Film club

3. **Digital communication**. Does the site make use of digital tools or representations to permit richer interaction with its users? For instance the school may invite feedback via message or email text boxes, it may advertise the use of social media or it may use visual devices (animation, panoramas, etc.) to enrich image representations. Consideration was also given to whether or not a school offered links to websites that might support their students' out-of-school learning with digital resources—or do so via the encouragement of parents or caregivers who see these links. The occurrence of such features were noted.

Scrutinising School Websites

We turn next to the findings from viewing and categorising the student experience themes outlined above and as represented on this sample of English primary school websites. The average number of coded image items on each site was 32. For each site, the total number of coded themes was calculated and then the count for each individual coded theme on the site was transformed to a percentage of that total. For each school this, therefore, provided a proportional profile of content conveyed by images. The mean value of these percentages across the whole sample is shown in Fig. 6.1. This shows the relative presence of each theme in what is a whole-sample profile. Because of our special interest in it here, the "computer" category is highlighted.

A similar analysis was performed for the data on extra-curricular clubs and their topics of concern. The results of this analysis are shown in Fig. 6.2. 60 % of schools advertised these clubs and described their topics. The Figure therefore shows for each topic category the mean percentage of all clubs in a school that feel into that category. This therefore is, again, a *profile* diagram: one that is constructed from the averages of investment patterns in named activities within each school's total portfolio in that area (i.e. the area of extra-curricular support).

Examples of student work based on digital tools was extremely rare. Six of the 151 sites had videos that were made by students. Three sites had podcast feeds to materials, some of which were made by students. In the large image category "our work", it was very unusual to see examples of material that had been digitally constructed or rendered.

The institutions themselves were also reluctant to describe themselves through digital representations. Only seven schools included a video presentation of their school site and/or some of its representative activities. Sixteen schools (10.6 %) presented blogs. These were often associated with individual classes. However, there were many pages where a "blog. " was advertised but the content turned out to be some form of teacher diary. We have taken an authentic blog to be a diary-like structure of postings where comments to postings are allowed. Seventeen schools (11.2 %) advertised a twitter feed. Much more common was a feedback template which allowed visitors (perhaps typically assumed to be parents) to send an electronic message to the school. 38 % of schools offered such an opportunity. In general, novel and engaging presentation devices were rare. Six schools used a panorama feature that allowed 360° exploration of some aspect of the site. Five schools used page turning publishing formats to enhance the reading of a newsletter or prospectus.

Finally, 36 % of schools published links to web-based learning material that students or family might engage with at home. However, it became clear that in most cases, these were sets of discipline-specific links that were recommended by web designing companies. Therefore often these had been included as a component in the design contract and the selection did not typically appear to be edited or appended.

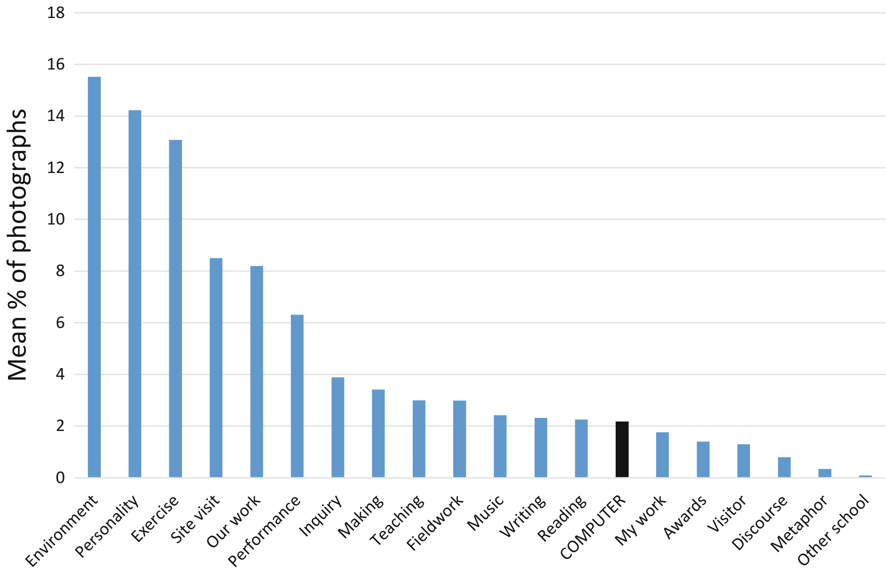

Fig. 6.1 Sample averages for each coded theme, expressed as a percentage of all coded themes on the same site

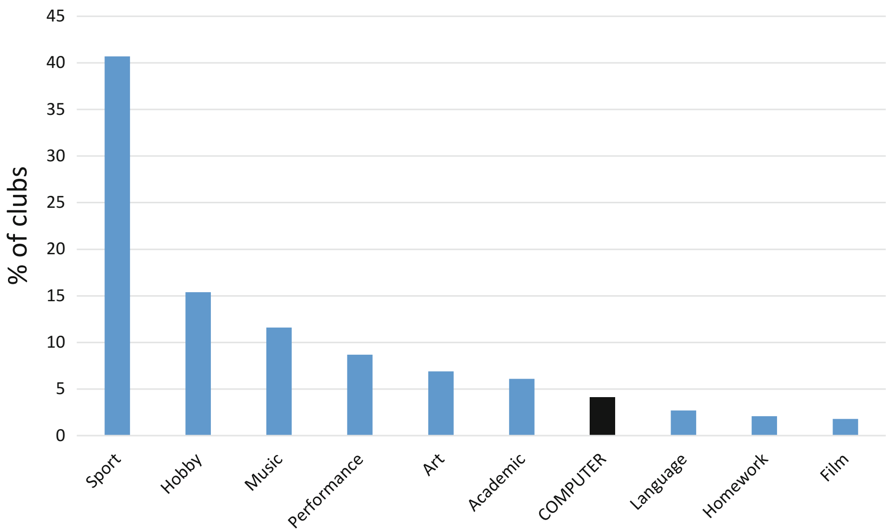

Fig. 6.2 For sites that did identify clubs, the mean percentage of all clubs identified on a site that fell into the named category

Summary of Digital Cultures Observed

The overarching impression that could be taken from this sampling of websites is that digital learning and digital representation are not highly developed or, better to say, highly prioritised in the culture of these primary schools. The purpose of this discussion is to develop further this conclusion and to consider whether it might need to be qualified.

In the introduction to this chapter, we note both the financial and teacher training investment that digital learning had attracted, and the various imperatives for schools to exercise and cultivate digital resources for education. It might therefore be expected that digitally mediated activities—their products and practices—must percolate up to website design. Yet in all the areas where we have looked for signs of vigorous digital learning or expression we find rather sparsely populated activities. Each of these areas may now be considered in turn.

First, in relation to representations of student activities, we have used website images as a barometer of student experience. This is not a well-worn procedure for characterising educational practice. Certainly, studies of the public representation of teaching and learning is more often approached through analysis of *textual* material (e.g. Alhamdan et al., 2014). It is less common to turn to public *images* as a basis for capturing the student experience (but see Wilkins 2012 for a critical study of identity and privilege management in images of private education). Yet it is reasonable to assume that in a context (the institutional website) which is broadly concerned with accountability and self-celebration, pictures should tell a complementary "story" to the various documents of performance and policy (that government dictates). In particular, they should tell a story that highlights a school's values and good practices.

The images we actually see are dominated by scenes stressing the agreeable and well resourced nature of the school site ("environment") and the good spirits of the students ("personality"). More specific reference to student experiences is then elaborated in terms of a strong emphasis on the *embodied* nature of schooling and the material fruits of its efforts. Therefore, we see many images of sport and physical games ("exercise"), out-of-school exploration ("site visit" and "fieldwork") and an acknowledgement of the artistic forms of active self-expression ("performance" and "making", along with its products as "our work"). Using digital tools is a rarely depicted theme.

Of course, published images of a given activity are not the same as direct and audited observations of that activity. So digital learning may be a very common part of the student experience but one not catalogued in the manner of image records. For example, it might be suggested that the theme "students using digital tools" is simply not very photogenic and so would make dull copy. However, there are many pictures of "exercise" or "site visits" or many other themes that are not visually engaging either. Similarly, where they did occur, there is evidence that images of activity with digital tools *can* be visually compelling.[7] Therefore, we tentatively

[7] http://www.slinfold.w-sussex.sch.uk/computing.html.

conclude that there is a strong drive to present the student experience as active, physical, social, and "child centred" (note the scarce number of images in which teachers are portrayed in instructional work ("teaching")): images that do not suggest the experience will be passive, sedentary and screen-focussed. We shall return to evaluate this conclusion below.

However, first, the observations above need to be complemented with others that we have made through these sites: others concerning different indicators of digital invention and representation. So we have noted that the digital *products* of children's work in digital media are rarely represented (although "our work" in the form of wall postings of traditional material is very common indeed). Again it could be argued that digital products are not visually appealing. But where they do occur it is clear that they are readily displayed and that they can look good.[8] Video made by students should also be a low-cost format to share in this medium—either directly or though the services of a YouTube channel. Yet it is rather unusual to find it.

We have also observed that support for (or appetite for) digital activities outside of the core curriculum is not revealed in these findings. So of the schools that run such extra-curricular clubs, 72 % of them do not embrace digital activity as a special focus in their extra-curricular repertoires. Finally, despite the good marketing imperative identified in our introduction, most websites are limited in the dynamic of interaction that they offer to users in their design. It is striking that most schools (79 %) use professional designers and that the field of companies called on is very wide (we noted 55 different design companies used by these 151 schools).

Evaluating the Projection of Digital Learning

One important fact to admit is that websites are not the only digital arena within which schools act. There are at least two others that need to be considered. So it can be assumed that most of these schools will have an active virtual learning environment (VLE). Moreover, it is possible that there is significant family engagement with this and that it provides parents and caregivers with a window onto the student experience. (Although it was not that common to find reference to these VLEs on websites.) Secondly, some schools encourage the use of smartphone apps that provide a more convivial means of keeping in touch with news, notifications and, perhaps, student in-school activity. The growing appeal (undocumented) of these apps is interesting in relation to the present results because it implies that there is an appetite in the sector for taking advantage of digital tools.

The availability of VLEs and school apps might suggest we consider the audience for which accountability is performed by school websites. Perhaps it is not for current students and their families but more for the benefit of other "outsiders": namely, (a) for inspectors and (b) for the parents of potential students. Insofar as the first category of audience is concerned much of the work done for them is actually

[8] http://www.st-andrews23.lancsngfl.ac.uk/index.php?category_id=16.

textual—documents that evidence good management and good performance outcomes. Yet it seems that images should effectively reinforce these messages and, if so, an orientation to digital learning would be one urgent theme to have reinforced. Regarding prospective parents, it must be in the gift of schools to judge exactly what they would regard as desirable or urgent for representations of learning experiences and we should respect that judgement. Yet the photograph does seem an effective and appealing way of communicating their judgement This is something that is advised by the consultant designers. For instance: "Our photographers consider every detail so you end up with a series of photos that portray the very best your school has to offer. From beautiful school grounds, to happy students, and even tablet-friendly 360′ virtual tours."[9]

If this marketing motive is a strong one, the photographic image is a useful carrier, and if schools are well motivated to impress … then the low website profile of digital learning might be understood in two ways. First, it may be that engagement with digital tools is now so much part of the daily routine of classrooms, that it is regarded as unnecessary to refer to it. Such learning is simply embedded in the background. This is possible but perhaps unlikely. First, where digital learning is portrayed it is not shown in the formats that such confident innovators might be expected to emphasise. Smartphones, data loggers and even tablets are quite rare in these images—which remain dominated by one or two students sharing a large computer screen. Moreover, the pervasive presence of technology and its comfortable use might imply the presence of more active school clubs developing it recreationally and more products of their activity shared online.

The second interpretation of a low profile for digital learning might mean that schools do not share the full enthusiasm of those employers, politicians and academics that celebrate this technology. This in turn might arise from one (or both) of two attitudes. First, there may be a sense that research does not reveal attainment outcomes that are proportional to the investment of budget and labour that the technology demands (Livingstone, 2012; Reynolds, Treharne, & Tripp, 2003). In defence of teachers, Underwood and Dillon (2011, p. 327) comment: "Attempts to bed in new technologies necessarily involve some level of disturbance to the educational system. The degree to which these perturbations are tolerated will affect technology acceptance. This raises the question of whether the educational system allows itself to be transformed or not." Other observers have argued that educational systems are not easily transformed and tend, instead, to be concerned to reproduce their own "blueprints" (Lenartowicz, 2014).

A more extreme version of this reticence might be developed around the proposition that computers have developed a toxic reputation, owing to their association with the less welcome features of young people's enthusiasms—and, of course, the wider world of suspect activities among adults. To be sure, the popular press is ready to stoke these concerns with stories of excessive home use[10] or head teachers

[9] http://www.e4education.co.uk/services.

[10] Retrieved October 15, 2015, from http://www.dailymail.co.uk/news/article-3016596/Head-teachers-report-parents-police-social-services-let-children-play-Grand-Theft-Auto-Call-duty.html.

who doubt the value of these devices for learning.[11] Moreover, there is a long tradition of scepticism around the appropriation of popular media into classroom experience (e.g. Lambirth, 2003). At the very least it is likely that many teachers feel an ambivalence between the so-called "old" and "new" models of pedagogy and their prescription to make fuller use of digital technologies (Erstad, Eickelmann, & Eichhorn, 2015).

Reflection

It is important to acknowledge a contested issue in separating and bracketing off as codes school activities. This can undermine any possible cross-curricular quality that these activities may involve. This bracketing was exercised via coding based on what was judged as represented in photographs but also drawing on the text and/or captions accompanying them, where appropriate. Only few schools had a distinctive cross-curricular character that celebrated some link, for example, between "science" and "art" activities. So in those cases it could be hard to identify clearly the content message of that which was represented. It is important to problematise the general representation of activities as so neatly bracketed into coded categories that reinforce their separation as subjects, as well as the separation of "fun" activities and "serious" learning. Typically, the accent on website representations is on the fun, whereas a more ethnographic insight into day-to-day school life would help to identify the extent of this separation probably to a greater level than shown in photographs. There are many photographs of highly playful activities and, of course, this can certainly be learning too, but it can not be clear from the websites how far this is how these activities are understood. The status of school visits may imply a similar problem. How are they related to the curriculum? More could be said about implications of this analytical exercise. But with limited scope here, others might open up further investigations based on this initial sketch of digital learning and its cultural context—as manifest on these websites.

Conclusion

We endeavoured to open a rare window onto the digital culture of the primary school, via a focused exploration of school websites. Our intention has been to sketch the "landscape" of digital learning representations. We have recruited a neglected tool of inspection (images) to make sense of what we find. In the increasingly market-oriented and accountability-vulnerable world of schooling, it is worth

[11] Retrieved October 15, 2015, from http://www.dailymail.co.uk/news/article-2916322/Schools-stop-wasting-money-buying-iPads-shiny-gadgets-pupils-spend-money-8-000-teachers-says-leading-head.html.

seeing how identity and enthusiasm is made public (or marketised) in this way. Our findings were surprising (to us at least). We discovered a distinctly low profile for the experiences of pupil invention, creativity and connected learning around digital tools. We have discussed what such a lack of website representational focus on "the digital school life" might mean. In addition, we find that extra-curricular *digital* activities are not thriving as strongly in the school environment as they appear to be thriving in homes, streets, and playgrounds. Finally, despite the expertise of the professional consultants that sit behind these site designs, we find only limited engagement with digital tools for cultivating communication, interaction or even "immersion" with users. At the same time, we have noted the rise of the school app: ubiquitous and powerful in its influence elsewhere in our worlds, we can perhaps expect it to be part of a force that levers future transformations of learning, expression and communication into more digital formats. In sum, it seems that any enthusiasm around promoting digital learning is not well reflected on school websites. Perhaps the digital is dwelling elsewhere: in ICT suites and school bags but, either way, it is rather hidden from wider view.

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Chapter 7
Corpus-Based Resources for L1 Teaching: The Case of Slovene

Špela Arhar Holdt, Iztok Kosem, and Polona Gantar

Abstract The chapter highlights the potential of corpus-based resources for language education in K-12, more specifically for L1 teaching in the higher grades of elementary school and in the secondary school. Presented are two freely available online resources that were recently developed for teaching and learning Slovene as L1. Firstly, the Šolar corpus (www.korpus-solar.net), containing approximately one million words, comprises of texts written by Slovene elementary and secondary school students. More than half of the corpus texts include teacher corrections of language errors; furthermore, the errors have been manually categorised according to the classification scheme developed specifically for the project. The primary purpose of the corpus is to enable empirical research into communication competence of Slovene students and, based on that research, improve the methods and materials for Slovene language teaching. Secondly, the corpus-based Pedagogical Grammar Portal (http://slovnica.slovenscina.si) is an online language resource offering interactive explanations of language problems most commonly experienced by Slovene students when writing. The portal is aimed at students aged between 12 and 18 years. The content of the portal is based on the analysis of three corpora: the Šolar corpus, the reference Gigafida corpus, and the GOS corpus of spoken Slovene. The chapter provides a description of the Šolar corpus and the Pedagogical Grammar Portal, focusing on the applicative value of the results. Furthermore, the acquired know-how regarding the design and the implementation of such resources is presented, e.g. by highlighting the biggest challenges of the projects, and the pros and cons of the applied solutions. Finally, the chapter offers a wider discussion on the usefulness of the results for L1 teaching in K-12 education.

Keywords Language corpora • E-learning • Student writing • Language problems • Corpus Šolar • Pedagogical grammar portal • First language (L1) teaching • Elementary school • Secondary school • Digital tools • Language resources

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Introduction

Language corpora[1] have had a considerable impact on language education for nearly three decades, both indirectly and directly (cf. Aijmer, 2009; Aston, Bernardini, & Stewart, 2004; Campoy, Gea-Valor, & Belles-Fortuno, 2010; Hunston, 2002; O'Keeffe, Mccarthy, & Carter, 2007; Römer, 2005, and Scott & Tribble, 2006). Indirectly, corpora influenced language learning through corpus-based or corpus-driven dictionaries (starting with the COBUILD dictionary in 1987), grammars (e.g. Biber, Johansson, Leech, Conrad, & Finegan, 1999; Hunston & Francis, 2000), syllabi (McCarthy, McCarten, & Sandiford, 2005–2006; Willis, Willis, & Davids, 1988–1989), various language teaching and learning materials, and were even used in language testing (e.g. Ball & Wilson, 2002; Coniam, 1997). Direct use of corpora, as in data-driven learning (DDL), also has a long tradition, going back to Johns (1991).

Another strand of corpus influence on language teaching has been via the creation and analysis of learner corpora, which according to Osborne (2002) provide a bottom-up approach to language teaching. Learner corpus research bibliography is considerable, evidenced by the bibliography of the Learner Corpus Association[2] which contains over 1100 references.[3] In addition, the learner corpus community has recently founded an association and started the conference series. Furthermore, the results of learner corpus analyses have been used in dictionaries like Macmillan English Dictionary for Advanced Learners. However, the use of corpora in L1 language teaching and learning is considerably smaller, and developmental corpora—as we signify L1 equivalents of learner corpora, following terminology in (Leech, 1997, p. 19)—remain rare.

In Slovenia, corpora have only recently been introduced to language education, after a period of establishing their value in the Slovenian lexicography and lexical studies, where they were first introduced to the Slovenian linguistic community. However, in contrast with the international experience, particularly in relation to English as a Second Language, the first introduction of corpora to language pedagogy was made in L1 teaching and learning.[4] Among the reasons that induced interest of the field for the corpus approach were: literacy scores of young native speakers who achieved below average results in the PISA evaluations; findings that identified existing approaches to language teaching as systemic and structure-oriented (Rozman, Krapš Vodopivec, Stritar, & Kosem, 2012); lack of teaching materials

[1] "A corpus is a collection of pieces of language text in electronic form, selected according to external criteria to represent, as far as possible, a language or language variety as a source of data for linguistic research." (Sinclair, 2005, p. 16).

[2] http://www.learnercorpusassociation.org/.

[3] Retrieved from https://www.uclouvain.be/en-cecl-lcbiblio.html.

[4] As for the L2 education, particularly noteworthy is PiKust, the pilot corpus of Slovene as a foreign/second language (Stritar, 2009). Currently, the applicative value of this corpus is somewhat limited due to its small size and unavailability to the general public. On the other hand, there have not yet been any larger-scale attempts to create corpora of Slovene native speakers communicating in foreign languages.

based on empirical evidence; and limited use of ICT in L1 language teaching compared to the use of ICT for teaching other school subjects.

In this chapter, we first present the Šolar corpus, a developmental corpus of Slovene writing. The compilation of the corpus is presented, and the methodological challenges and lessons learned are pointed out. As part of the project we describe, the Šolar corpus was made available to the general public via a customised concordancer, providing teachers and students with the opportunity to examine authentic written production in a qualitative, as well as quantitative way. Secondly, the data from the Šolar corpus was analysed and organised by the project team, and a set of ready-to-use corpus-based teaching materials were prepared. The materials were made available in a form of interactive, user-oriented resource, called the Pedagogical Grammar Portal. In this chapter, we present the features of the portal and the innovations the corpus-based materials bring to the Slovene language teaching. Following that is a discussion on the value of the portal for language pedagogy and a report on the initial feedback from the teachers. We conclude by outlining the plans for the future, and discussing the implications of the project for the use of corpora in L1 teaching and learning in Slovenia as well as in other countries.

Corpus Šolar

Idea and Implementation

The Šolar corpus was created as a part of the "Communication in Slovene" project, a national endeavour aimed at establishing language resources for the Slovenian language (different types of corpora and corpus annotation tools, language databases etc.).[5] The main purpose of the Šolar corpus was to enable empirical research into communication competence of Slovene students and, based on that research, improve the methods and materials for Slovene language teaching. To compile the corpus, a large quantity of authentic texts that students have written as a part of their coursework (essays, school tests etc.) had to be collected from a number of Slovene schools. The collection was conducted in close cooperation with the teachers, who have provided photocopies of the students' texts. A significant quantity of the received photocopies also included feedback that the teachers had provided to the students, namely corrections of students' language errors (spelling, morphology, syntax, vocabulary, punctuation, etc.). When transcribing the texts into digital form, these corrections were converted into annotations, increasing the value of the corpus data for research and educational purposes.[6]

[5] The project (2008–2013) was financed by European Social Fund and the Slovene Ministry of Education, Science and Sports. Information about the project is available at http://eng.slovenscina.eu/.

[6] Corpora containing texts of young L1 speakers are very rare, especially the ones with annotated errors; from this perspective, the Šolar corpus represents a potential for innovative research not only in L1 education but also in various fields of theoretical and applied linguistics, natural language processing, and language technology development.

The design principles and the corpus building process were already presented to the international public in (Kosem, Rozman, & Stritar Kučuk, 2011) and in more detail to the Slovene public (Kosem et al., 2012). In this chapter, we therefore provide only a basic overview of the corpus content, followed by a presentation of the part of the corpus that includes teacher corrections, the corpus interface and the methodological challenges of the project.

The Šolar corpus comprises of texts written by Slovene elementary and secondary school students (aged between 12 and 18 years).[7] In its current state, the corpus consists of 2703 texts, more than half of which include teacher corrections of language errors. The total number of words in the corpus is 939,243 (excluding the teacher corrections). The texts, many of them graded, were produced as part of the coursework, mainly at Slovene (82.3 % of the texts). Much fewer texts (between 0.1 and 4.6 % of the texts) were obtained from other school subjects such as psychology, sociology, history, and geography. Majority of the texts are essays (79 %), the rest are tests (14 %) and other written school products such as letters, memos etc. (7 %). The texts were produced by students at high schools (43 %), students at technical schools (31 %), pupils at elementary schools (14 %) and students at vocational schools (5 %). Due to rich dialectal variation in Slovenia and the potential influence of specific dialectal features on the production in standard Slovene, it is also important to have a regionally balanced corpus. The Šolar corpus is only partly successful in achieving this aim: the texts are from all Slovenian regions; however, some regions have a very low share, especially Gorenjska (northwestern part of Slovenia) and certain smaller regions (e.g. Postojna region). However, the ratio between texts coming from South-West regions and North-East regions is approximately 3:2, which somewhat reflects the size of the area and the population.

The included texts were mainly produced in the school year 2009/2010. As already mentioned, the compilation of the corpus was conducted in cooperation with teachers of the selected schools who helped obtain permission from students and parents (for students and pupils under 18) for making the texts freely available, prepared photocopies of the material, and provided the necessary metatextual information. The second step of the corpus creation was the transcription of the written material to the digital form. In this process, the transcribers used XML tags to annotate language errors and teacher corrections (see Fig. 7.1). The transcription process proved to be more time-consuming than expected, and hence not all the collected texts could be included in the corpus.[8]

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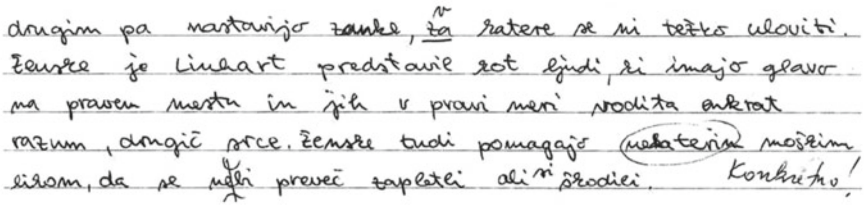
[7] Other information on the authors of the texts, such as gender and Special Educational Needs Status was not collected for two reasons: firstly, more information would increase the possibility of identifying the authors, and secondly, including more sensitive data would make obtaining permission from the parents more difficult.

[8] Out of 8594 texts collected only 2703 were included in the corpus. It is also noteworthy that around 14 % of the gathered material was not suitable to be included due to lack of metalinguistic information, low quality photocopies and similar problems.

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drugim pa nastavijo zanke, <u tip="B">za<p>v</p></u> katere se ni težko uloviti. Ženske je
Linhart predstavil kot ljudi, ki imajo glavo na pravem mestu in jih v pravi meri vodita
enkrat razum, drugič srce. Ženske tudi pomagajo <u k="Konkretno!"
l="obkroženo">nekaterim</u> moškim likom, da se <u tip="Z" podtip="SN">nebi<p>ne bi</p></u>
ne bi preveč zapletli ali si škodili.
```

Fig. 7.1 Student's text with teacher's corrections, and the annotation in the Šolar corpus

Language Errors and Corrections in the Corpus

To clarify the process of the annotation of language corrections, we present an example in Fig. 7.1. Above is an excerpt from an essay written by a student and corrected by a teacher. Below is the same text, as prepared for the Šolar corpus: the transcriber retyped the text and included the corrections in a form of XML tags.

As can be seen from the XML tags (attributes "tip" and "podtip", i.e. Category and Subcategory) in Fig. 7.1, the transcribers also assigned linguistic categories to errors and corrections. The annotation scheme was based on the classification designed for error tagging in a pilot corpus of Slovene as L2 (Stritar, 2009), with some minor adaptations (e.g. the category "abbreviation" was added for the purposes of the Šolar corpus). The categories of errors are presented in Table 7.1.

Annotated language errors and corrections can be found in 56 % of texts in the Šolar corpus. Nearly all of the corrected texts were produced at Slovene, which is understandable, as this subject is the most oriented towards the development of pupils' and students' writing skills. The predominant genres are argumentative and narrative essays. The text origin according to the type of school is shown in Table 7.2.

The teacher corrections in the texts are of different types, from underlined text and crossed out text to comments and suggestions for improvement of style. All the original corrections have been included in the digital form, and no additional corrections have been applied. The corpus data thus reflects not only the most typical language errors of students, but also highlights the correcting practices of the teachers.[9] Basing the error annotation and analysis solely on teacher corrections is an important methodological decision that needs to be taken into account when

[9] While the Šolar corpus is mainly intended for the investigation of the language production of students, the corpus can also be used as a consultation tool for language teachers. In teacher training, the corrections can be examined to better understand and to some extent standardise the strategies of interventions in student texts.

Table 7.1 Language errors in corpus Šolar

Error category	Error subcategory	Number of errors	Example from the Šolar corpus
Orthography	Spelling	2672	V času *razsvetljenjstva* ǀ *razsvetljenstva* so se ljudje začeli zavedati razuma.
	Together/Apart	1179	Zato se Simon *nemore* ǀ *ne more* osvoboditi ustanove.
	Capitalisation	2125	Znano je, da se ga je *Baron* ǀ *baron* Naletel skušal znebiti, saj je osvajal Nežko.
	Punctuation	15,371	To nam pove tudi verz" ǀ „ Ne maram ga, kdor le z besedo ljubi!"
	Abbreviation	23	V šoli sem 5 *h* ǀ *ur*.
	Numeral	50	Ko mi je bilo *12* ǀ *dvanajst* let, smo se s starši in prijatelji odpravili v Gardaland.
Vocabulary		3807	*Prizna* ǀ *Spozna*, da je Matiček njegov sin in Smrekarica je tako Matičkova mati.
Morphology		3618	*Vojno* ǀ *Vojne* ne jemlje tako resno kot Gregor.
Syntax	Word order	1265	Šele zdaj vidim, da je *za tisti čas bila* ǀ *bila za tisti čas* zelo napredna.
	Missing text	1607	Po navadi ǀ *tistega časa* naj bi bile žene poslušne možem.
	Redundant text	2665	Cankar je v drami prav tako razgalil politično prilagodljivost *tudi* ǀ učiteljev.
	Erroneous structure	653	*Tu je pomembno to* ǀ *Pomembno je*, kako so kmetje vztrajali pri maternem jeziku.

Table 7.2 Texts with language corrections regarding the type of school

Type of school	Texts	Percentage of texts	Words	Percentage of words
Elementary school (6th–9th grade)	395	26.1	110,828	19.1
High school	404	26.6	239,146	41.1
Technical school	574	37.9	186,784	32.1
Vocational school	143	9.4	44,719	7.7
Total	1516	100	581,477	100

interpreting the results of corpus analysis. Namely, when correcting texts, teachers consider student competence and other contextual specifics of the text. This means that the treatment of language errors is not completely comparable and consistent from student to student.[10] Nevertheless (or consequentially), the corpus is representative of school writing, and the valuable insight into the process of language correcting in schools extends the corpus value beyond merely statistics on language errors in student writing.

[10] For the time being, teacher corrections have not yet been thoroughly analysed; however, some preliminary findings reveal a certain level of inconsistency between the practices of different teachers, also in relation to the existing language norm.

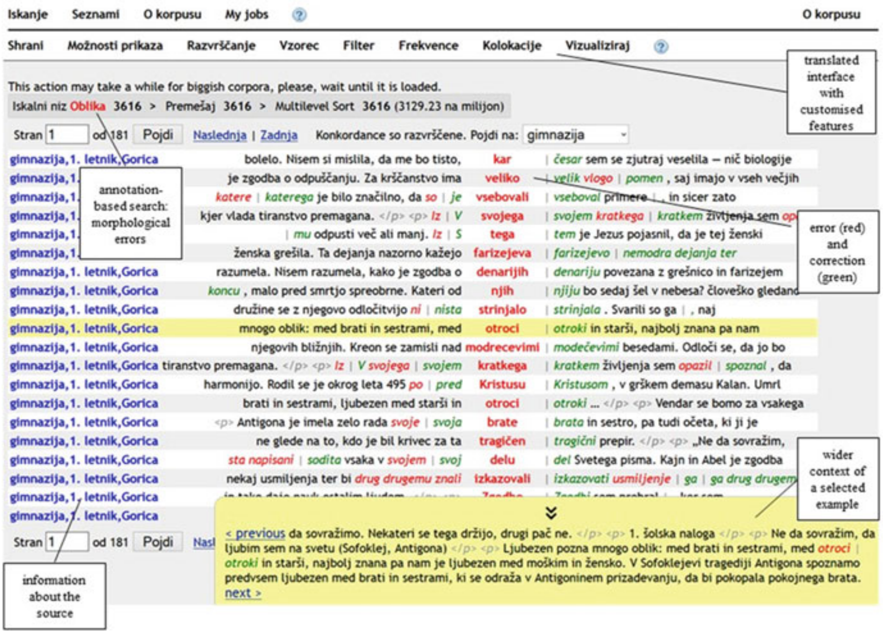

Fig. 7.2 Morphological errors in the Šolar corpus

Corpus Concordancer

As the corpus contained annotated errors and corrections, available concordancing tools were not suitable for its use. Therefore, we developed a new interface, based on the widely used Sketch Engine corpus tool (Kilgarriff, Rychly, Smrz, & Tugwell, 2004), which was localised and customised for the purposes of displaying data from error-annotated corpora. A similar Sketch Engine-based concordancer is already used by Cambridge University Press for their learner corpora, but their concordancer is aimed at researchers who are more advanced users of corpus tools. Contrarily, our target users were primarily of wider audience (e.g. teachers), so a great deal of attention was paid to the means of clear and simple data presentation. The localisation included translating the interface into Slovene, developing help and tips on how to search the corpus, and simplifying the interface language (eliminating abbreviations and terminology). The customisation addressed mainly the development of innovative ways of presenting corpus data, especially demonstrating language errors and corrections in a user-friendly manner, and developing functionality for searching and manipulating corpus data (Fig. 7.2).

In addition to regular functions of the Sketch Engine tool, the Šolar concordancer also allows searching by language errors and corrections. The users can look up specific error (e.g. the occurrences of errors containing the personal pronoun *moj*); error-correction combination (e.g. all the errors where the pronoun *moj* was replaced with reflexive pronoun *svoj*); or all the errors of a particular error category (e.g. all the instances that were annotated as morphological errors). The results are shown in KWIC format, as in most concordancers, with the searched error or correction shown in the centre. For easier interpretation and overview, the language errors are shown in red and the corrections in green. The default view does not show tags (which can be activated if needed), as is the case with the Cambridge University Press interface, since testing has shown that tags make the concordances difficult to read. The concordances can be manipulated, e.g. the users can sort, sample or filter them, as well as save them for further use. In addition, the concordancer offers some possibilities of data summarisation, such as a collocation list, frequency distribution of errors by error type and metatextual information (type of school, region, year/grade etc.).

Methodological Challenges and Lessons Learned

One of the main challenges of the compilation of the Šolar corpus was the transcription of the student texts. In fact, initially, more problems were expected with obtaining the student texts, nevertheless the response from the Slovene teachers at schools was overwhelming. On the other hand, the transcription was problematic not only because the texts were handwritten (and as such sometimes difficult to decode), but also because the received photocopies were in black and white (not in colour), which often made it difficult to distinguish teacher corrections from student text.[11]

However, by far the most demanding and time-consuming part of the transcription proved to be annotation and categorisation of student language errors. The transcriber's task was to correctly transcribe a handwritten student text, annotate the errors in the text using XML tags, annotate the teacher corrections of the errors, and categorise each error using the attribute in the tag. The transcription was conducted in Microsoft Word, which was selected because transcribers were most familiar with it, and a number of macros were prepared to save transcribers' time. The subsequent evaluation revealed that the transcribers had many difficulties with combining linguistic skills (annotation and categorisation of errors) with technical ones (using XML tags and macros), which resulted in the mistakes on the linguistic side, e.g. incorrect category for the error used, and on the technical side, e.g. incorrect XML format. The former problem was mainly addressed by introducing a thorough check of all the texts with annotated errors, while the latter was addressed semi-automatically with validation tools after all the texts had been transcribed and checked. This prolonged the compilation process and resulted in a fact that fewer texts were included in the corpus.

[11] While teachers might have been able to help us solve some of these problems, that would have been time-consuming both for them and the project, and it would considerably prolong the transcription process.

Pedagogical Grammar Portal

Idea and Implementation

Since it is freely available online, the Šolar corpus facilitates insight into authentic language practices of Slovene students to the interested general public. Teachers might, for example, use the corpus data to improve their teaching materials (e.g. find examples, create exercises and tests) or to prioritise the topics of their teaching to better address the language problems, reflected in the corpus. However, such use of corpora has its limitations, the most important one being the time one has to invest into the preparation of such materials. Thus, one aim of the "Communication in Slovene" project was to develop a set of ready-to-use corpus-based teaching materials and make them available to the teachers and students in a form of an interactive online resource. The result of this project activity was the Pedagogical Grammar Portal, a freely available multimodal resource, consisting of several units (chapters) that focus on the most typical language problems students encounter while writing in standard Slovene (see Table 7.3).

As mentioned previously, teacher corrections in the Šolar corpus were first categorised into 12 robust linguistic categories (Table 7.1). For the identification of the most typical student problems, a more fine-grained categorisation was needed. Our decision was to conduct a manual (sub)categorisation of the corrections using a bottom-up categorisation approach; however, the annotation procedure had to be improved. The overview of existing annotation tools showed that there are very few tools for error annotation available, especially tools that would have allowed us to import error-annotated corpus and categorise existing errors further. In the end, WordSmith Tools (Scott, 2008) proved the tool most suitable for our purposes, even though its main shortcoming was that it only allowed categorisation within the tool; making changes directly into the corpus file(s) was not possible.

As a result of this process, 692 different categories of language problems were identified (Kosem et al., 2012): by far the most frequent problem was the use of a comma, also often causing problems was the declension of certain nouns, spelling of certain words (e.g. *življenje*), use of possessive and reflexive-possessive pronouns, use of infinitive and supine, use of modal verbs *moči* and *morati*, use of comparative and superlative forms of adjectives etc. In the second step, priority lists with problems of different type/frequency/regional distribution were created (Arhar et al., 2011, pp. 50–57), and used as a basis for the conceptualisation of the portal, the development of its wireframe and design, and the customisation of the selected Content Management System (CMS). In the final stage of the project, 24 chapters[12] of interactive corpus-based teaching material were prepared by a team of linguists

[12] The Pedagogical Grammar Portal consists of *chapters*, i.e. self-standing ready-made teaching units that revolve around a specific topic (e.g. the use of supine in Slovene). The structure of the chapters on the portal is presented in more detail in section "Structure of the PGP Chapters" (see Figs. 7.3 and 7.4).

Table 7.3 Language problems presented on the Pedagogical Grammar portal

	Topic	Example from the Šolar corpus
1	Spelling of negated verbs	Tak odnos nima smisla in se *nemore* ǀ *ne more* srečno končati.
2	Declension of the irregular noun *otrok*	Dandanes je vez med starši in *otroci* ǀ *otroki* veliko večja.
3	Use of prepositional variants *s*/*z*	Na koncu je odšla *s* ǀ *z* botrom Esadom v Nemčijo [.]
4	Use of prepositional variants *k*/*h*	Kasneje sta se Raymond in Mersault vrnila *h* ǀ *k* Arabcem [.]
5	Reduction of the infinitive	[N]aučila jih je, da je v življenju treba *delat* ǀ *delati* in se *borit* ǀ *boriti*.
6	Use of supine	Pobriše mizo in se odpravi *pomivati* ǀ *pomivat* posodo.
7	Umlaut in noun declensions	Oba se ranita z zastupljenim *mečom* ǀ *mečem*.
8	Use of verbs with –te/-ta and –ste/-sta	Sklenila sta ǀ, da se *bota* ǀ *bosta* poročila.
9	Use of modal verbs *morati* and *moči*	Kajn je *mogel* ǀ *moral* bloditi po svetu.
10	Spelling of past active participles with *-l*	*Delav* ǀ *Delal* se je norca iz njega [.]
11	Spelling of preposition *v*	Janez je *u* ǀ *v* mestu zelo veliko razmisljal o njej ǀ, kako je lepa.
12	Negation of adjectives	[V]anj se *ne normalno* ǀ *nenormalno* zaljubi [.]
13	Words with *izs-*	Opazovalec prispe na cilj in *iztopi* ǀ *izstopi* iz avtobusa [.]
14	Words with *-lj-*	Povezanost pomeni sožitje, medsebojno spoštovanje in *prijatelstvo* ǀ *prijateljstvo* narodov.
15	Words with *-nj-*	Ta mu pove, da ga vidi *zadnič* ǀ *zadnjič*, ker se je dala krstiti.
16	Spelling of words with double letters	Vendar župnik na koncu Jermanu *vseno* ǀ *vseeno* prizna, da je ravnal prav.
17	Use of *nobeden* and *noben*	Pripovedovalec je ugotovil tudi, da se *nobeden* ǀ *noben* drug potnik ni zmenil za to gospo [.]
18	Use of pronouns *nobeden* and *nihče*	Bog pa mu je dal znak, da ga *noben* ǀ *nihče* ne bi ubil.

Table 7.4 Online language resources, presented on the Pedagogical Grammar Portal

Topic			
1	Corpus Gigafida	4	SSKJ dictionary of standard Slovene
2	Corpus GOS	5	Slovene orthography 2001
3	Sloleks morphological lexicon	6	Orthography Guide

and teachers: 18 chapters focusing on specific language problems (Table 7.3), and 6 chapters describing available online language resources for Slovene (Table 7.4).

Each presentation of a language resource starts with a description of how the resource was created, then offers 3–5 video tutorials on how to use the resource to solve different types of language questions, points out any limitations of the resource, and finally challenges the user to answer a set of language questions using the presented resource. These chapters were added to the portal so they can be referred to when describing solutions for specific language problems.

The preparation of the chapters on language problems, on the other hand, posed a considerable challenge because no large-scale corpus-based description of Slovene grammar was available at the time. Therefore, the first step of preparing each chapter included a detailed analysis of corpus data for the selected problem. Three corpora were used: the Šolar corpus, a corpus of spoken Slovene GOS,[13] and a reference corpus of written Slovene Gigafida.[14] As the first two corpora are smaller and content specific, the analyses were conducted in their corresponding concordancers. Gigafida, however, facilitated a more synthetic, quantitative approach with automated data extraction and organisation. Some of the findings of these studies were presented to the (Slovene) linguistic audience, together with the methodology used (Arhar Holdt & Stritar Kučuk, 2012; Može, 2013).

The results of corpus analyses brought another challenge: the newly acquired insight into the chosen language phenomena differed significantly from the existing language description, and in some instances in opposition with the current linguistic norm. This gap was to some extent expected, since it is widely recognised that "corpora have provided evidence for our intuitions about language and very often they have shown that these can be faulty when it comes to issues such as semantics and grammar (O'Keeffe et al., 2007, p. 21)". The extent to which traditional dichotomies (written vs. spoken, formal vs. informal, correct vs. erroneous, lexis vs. grammar) were challenged by the new data was nevertheless surprising. Consequentially, an important task in the design of the PGP was to present these new findings without creating unnecessary conflicts with the existing reference books and teaching materials. A middle way, determined in cooperation with experts from the fields of linguistics and language teaching, was demonstrating actual language use with a democratic view of different language choices, while at the same time highlighting the specifics of the current (codified) standard the students are expected to master in the educational process. Our decision confirmed anticipations that corpus-based studies will impact language teaching by replacing monolithic grammar descriptions with register-specific ones, integrating teaching of grammar with teaching of vocabulary, and shifting emphasis from "accurate" to "appropriate" (Conrad, 2000, p. 549). Larger-scale evaluations of the Pedagogical Grammar Portal, planned for future work, will aid in establishing the success of this integration.

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[13] GOS is the first corpus of spoken Slovene. It consists of approximately 120 h of recorded speech in various situations. The content, structure, and availability of the corpus, as well as the specifics of its custom-designed interface are described in (Verdonik, Kosem, Zwitter Vitez, Krek, & Stabej, 2013).

[14] Gigafida is the most recent, and with nearly 1.2 billion words also the biggest, of Slovene written corpora. Information about the corpus is available in (Logar & Krek, 2012).

Use of Corpus Data on the Portal

Corpora are not (yet) systematically incorporated in the Slovenian education process and are also not included in existing curricula. Consequently, teacher training on the use of corpora in the classroom is not provided.[15] Hence our decision was to design PGP as a resource that uses corpora indirectly (according to typology in Leech, 1997), meaning that corpus material is not presented to the user directly via a concordancer, but rather preselected and organised for particular educational purposes. Another reason for such use of corpus data was the already mentioned desire to produce ready-made materials that facilitate instant integration into the teaching progress and are easy for students to access and use both in classroom and at home.

On the PGP, corpus material is usually provided in a form of short sentences that exemplify specific features of language use. The only editing procedure in the preparation of corpus examples was the (optional) shortening of sentences, as we believed long and complex examples would shift the focus of the users away from the actual purpose of the chapter.[16] The second type of corpora use was to prepare supportive visual material for the chapters, such as frequency-based word clouds, word lists, and charts.

On the portal, different corpora are used for different purposes. The Gigafida corpus, as a reference corpus of written Slovene, is used to explain the discussed language phenomenon in general (e.g. how supine is used in written Slovene), and to visualise supportive language data (e.g. a word cloud with most common Slovene verbs to help the user identify and understand the part-of-speech category). The Šolar corpus, on the other hand, is used to exemplify the specifics of the discussed language problem, e.g. to represent what errors/corrections typically occur when students use supine in their writing. Thirdly, as the aim of the PGP is to improve the written production of the students, examples from the GOS corpus are included to highlight the differences between written and spoken Slovene. GOS is also used for demonstrating specific dialectal features in comparison to the standard language.

Innovation in Slovene Language Didactics

Using the corpus approach when developing the PGP introduced several novelties to Slovene language didactics. We discuss some of these decisions in section "The Value of the Pedagogical Grammar Portal for the Slovene Language Education":

[15] Despite this fact, more and more teachers are becoming aware of the existence of corpora and their educational potential. In section "Preliminary Feedback from Teachers" we summarise the experience from the workshops for teachers on the use of language resources and technologies in language teaching.

[16] A debate in corpus linguistics on (non)authenticity of decontextualised corpus data is summarised in (O'Keeffe et al., 2007, pp. 25–27).

- prioritisation of the teaching content according to the frequency of language errors in student writing;
- conceptualisation of explanations from specific language problems rather than from the grammar system;
- use of authentic corpus examples to support explanations;
- representation of language use as it appears in various genres (written and spoken, standard and non-standard);
- inclusion of a high number of interactive corpus-based exercises;
- different treatment of language problems, common to all or nearly all Slovenian regions, and problems limited to individual region(s).

With these features as starting points, the online interface of the Pedagogical Grammar Portal was designed by a team of experts: linguists, language teachers, designers and programmers. One of the most important decisions in the preparation of the portal was connected to the organisation of the content. Unlike existing resources for teaching Slovene as L1, which are based on topics from the grammar system selected with top-down approach, the topics in the PGP were selected bottom-up from the student language production. Consequentially, we decided to present each language problem as an independent, self-standing chapter. At the beginning of each chapter, the user is equipped with the metalinguistic knowledge needed to understand the explanation of the language problem. From then on, the focus is on the problem: its characteristics; possible reasons for it; and the suggested solutions, i.e. the use of mnemonics to remember the grammar rules, the use of reference books or resources, or the use of techniques to improve writing strategies. The explanation of a language problem is divided into smaller units, and each of the units is supplemented with a short exercise to activate the users and promote continuous self-evaluation of the progress (Fig. 7.3). A high number of interactive corpus-based exercises at the end of each chapter facilitates automatisation of the use of language rules and consequently the transfer of the knowledge into practice (Fig. 7.4).

A great deal of attention has been paid to the language of the explanations. Unnecessary use of terminology is avoided, as is the use of complex syntactic structures. The language used is concrete and concise. Supportive information—definitions of terms, theoretical background, additional statistical information, tables with word forms, word lists etc.—is removed from the central explanation and made available to the user in the form of clickable side tags (Fig. 7.3). As the PGP is aimed at students of different ages (12–18), we made every effort to make the primary content as clear and straightforward as possible, hoping to ensure comprehensibility for the younger users while still providing the older users with additional useful information for better understanding of the problem in a wider context. Another reason for the simplification of the language was our aim to facilitate students' independent use of the PGP. Namely, the portal was conceived and developed to support individualised approach to improving students' writing skills: after the evaluation of the students' written production, the teacher can choose to assign each student only the chapters relevant for his/her language problems, instead of covering the same grammar topics with the entire class regardless of student-specific strengths and weaknesses.

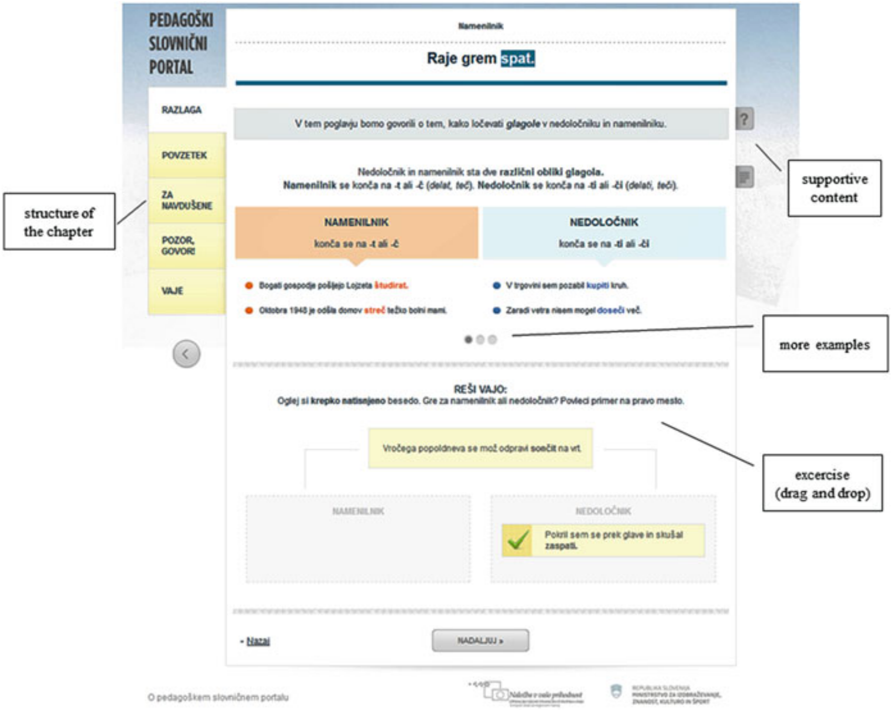

Fig. 7.3 Explanation of the use of supine (*namenilnik*)

Structure of the PGP Chapters

The chapters on the portal follow a standard structure, containing obligatory (1–5) and optional (6) elements:

1. Introduction, where the users can determine whether the topic of the chapter is relevant to them or not. To help them with deciding three examples of student errors (and teacher corrections) from the Šolar corpus are provided.
2. Explanation of the language problem with suggestions/techniques for its solution. The content is separated into 3–5 shorter units, each of them supplemented with short exercises and tasks to activate the users.
3. A one-page summary of the presented content.
4. A sub-chapter with additional information on the language problem (e.g. interesting facts from the history of the Slovenian language or corpus statistics) with links to external resources. This sub-chapter is aimed at motivating the users to utilise existing resources for Slovene for further investigation of the discussed topic.
5. A large number of exercises, presented to the users in chunks of 10. Exercises are automatically rated and the users can monitor their results over time.

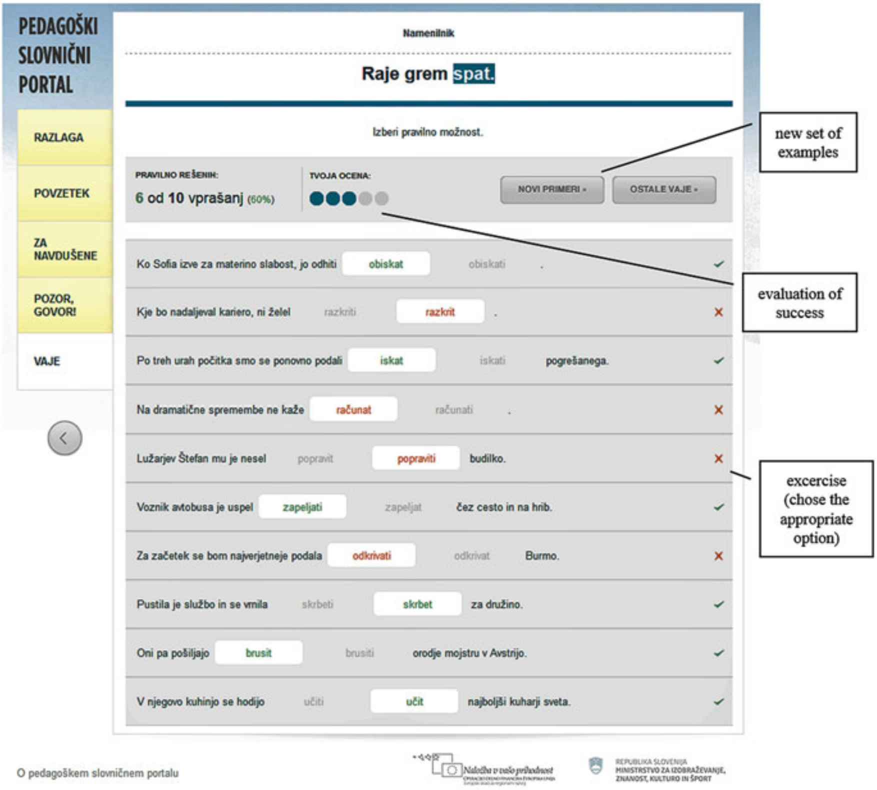

Fig. 7.4 Exercises on the use of supine (*namenilnik*)

6. Additional warnings, typically about the exceptions to the presented language rules, regionally relevant aspects of the language problem, or noteworthy specifics of the relation between written and spoken Slovene.

Figures 7.3 and 7.4 present two pages from the chapter on the use of supine, the first page of the explanation of the problem and a set of (solved) grammatical exercises. There is not enough space to describe the structure of the portal in greater detail, but the readers are welcome to examine it on http://slovnica.slovenscina.eu/.

The Value of the Pedagogical Grammar Portal for the Slovene Language Education

When we think about the potential value that the PGP has for the Slovene language education, we need to consider it in the context of the existing situation in Slovene primary and secondary education where online language resources and ICT have only recently, and in small steps, been introduced to teaching Slovene as L1 (Rozman, Krapš Vodopivec, et al., 2012, pp. 91–100). The available online teaching resources are fairly basic in content and form (Arhar et al., 2011). What is more, teaching materials and methods are not corpus-based (see Aston, 2001 for arguments in favour of such practice); the same can be said for existing reference works such as dictionaries and orthographies. The main reasons for such a situation are uneven distribution and unbalanced prioritisation of content and the belief that ICT cannot play a significant role in language teaching as it does in other subjects such as natural sciences. The development of online language resources is language specific, i.e. materials cannot be taken from other languages and simply translated. Therefore, online language resources need to be developed from scratch, which requires time and money. In Slovenia, lack of resources and funding[17] has presented the biggest obstacle to development and implementation of ICT in L1 teaching in Slovenia. Thus, the PGP is faced with two main challenges. The first one is technical and has to do with taking advantages of the online medium such as multimedia, hyperlinks and customizability for presenting language content more effectively. The second challenge is about introducing corpus methodology and corpus-based materials into Slovene schools, which raises questions about whether the Slovene educational system is ready for such a pedagogical language resource[18] and whether the pedagogical purpose of the PGP and the corpus methodology used in its compilation are compatible.[19] The discussion on the linguistic potentials of the PGP for the Slovene education will focus mainly on the latter challenge.

Implementing Corpus Methods into L1 Teaching: Challenges, Advantages and Dangers

Introducing corpus methodology and corpora as language resources to L1 teaching in schools is one of the essential steps towards bridging the gap between real language use and student language problems, and language content in existing textbooks. The PGP achieves that by offering a large number of authentic corpus examples, both as part of the explanations of the problems and in the exercises. Because many examples are taken from a corpus of student writing, it is likely that their content will be familiar to the (student) users which will make the identification with the

[17] This has been exacerbated by the economic crisis, during which the funding allocated to education in Slovenia has been constantly decreasing.

[18] This would also mean providing regular training of teachers on how to work with corpora in the classroom (see section "Preliminary Feedback from Teachers").

[19] The developers of the PGP were unable to inform their decisions on how to implement corpus data into education process using online language resources (particularly in L1 teaching) using examples of good practice from abroad. Namely, the PGP is in many ways a unique pilot project where a new form of teaching and learning materials and strategies are being developed and tested.

language problem easier—this is one of the important advantages that PGP has over existing textbooks.[20]

This new approach to teaching Slovene is based on explaining linguistic phenomena with real language situations and shifts the focus from the accumulation of factual knowledge, found in existing textbooks, to language competence. Another advantage of the PGP lies in the fact that it attempts to utilise intertextuality and interactivity of the digital media.

In addition to more adequate representation of authentic Slovene, the corpus-based approach introduces new terminology (e.g. concordancer, tagger, language technologies) into language materials, as well as links to language resources and tools for Slovene—corpora, grammar checker, morphological lexicon etc.—which help raise awareness among students of the increasingly important role of information science in the field of linguistics. The absence of interdisciplinary links between linguistics and computer science in existing textbooks does not reflect the recent developments in linguistics and the reality of the digital age in which (soon to be) competent users of language live. In this aspect, the PGP presents a good model that should be used when revising and updating the Slovene syllabi and in planning online language resources.

A Shift in the Conceptualisation of Language Phenomena

The planned shift in the conceptualisation of language phenomena in comparison with the existing linguistic theory is evident in the presentations and explanations of the problems which are not tied to the structure-focused view of the language system, but are problem-driven. Moreover, the presentation of the solution to the problem links morphology and syntax, word-formation and semantics, grammar and norm, which highlights internal co-dependency of language phenomena. This is a novel approach in Slovene language teaching,[21] and benefits from the multidimensionality of the online medium.

The introduction of real language use into language teaching, a consequence of the PGP using corpus methodology, is accompanied by at least two more dilemmas directly connected with conceptualisation of language phenomena in existing textbooks and materials for Slovene. Firstly, examples of real language use inevitably show language variation, as opposed to language description in existing textbooks where only one variant of many is often presented as the correct one (Rozman, Krapš

[20] In the survey conducted by Rozman et al. (2012: 106–108) the students listed mind maps and charts as the preferred explanatory methods for language content, whereas examples and images received lower scores. This could be linked to the finding that the students find examples in existing textbooks uninteresting, unreal and atypical (ibid. 108).

[21] The survey conducted among teachers of Slovene as L1 (Rozman, Krapš Vodopivec, et al., 2012, p. 75) showed that most of them agree with structure-oriented grammar teaching (separated in subfields, such as phonology, morphology, lexicology, syntax), and believe that this leads to the development of students' communication skills.

Vodopivec, et al., 2012, p. 60). Secondly, language learners, as future competent language speakers are expected to learn to linguistically and pragmatically argument their language decisions. If the traditional approach is based mainly on knowing rules and norms of the language, the PGP builds the learner's/speaker's language competence by teaching functional variation which depends on the communication situation, or in other words, by teaching that language choices depend on the context (formal and informal), and regional, genre and stylistic characteristics. With other words, the main difference between both approaches is, that the PGP aims to raise the awareness of the speakers to make informed language choices, while the traditional approach focuses almost exclusively on the standard language.

To sum up, the value of the PGP for the Slovenian education lies in the combination of a synthetic, problem-oriented approach to language with attempts for user-friendliness, that introduce mnemonics to facilitate the acquisition of language rules and combine simple and easy-to-understand language descriptions with fun and interesting exercises; this combination results in showing the learners a specific language phenomenon in its variety, with more than one possible grammatical solution, yet exposes the solutions in accordance with the existing standard as the natural choice for the written production students are to master in the process of education. The question to what extent and in what manner the students, especially in elementary schools, are ready to learn about language variation, remains to be more thoroughly researched, and the creation of the PGP can facilitate an insight into this area. The same applies to teachers who need to be familiar with the characteristics of corpus approach in language teaching. In addition, they need to be able to adapt the teaching strategies to successfully teach their students how to choose the suitable variant in a given communication situation from the variety of data offered by corpora. In order to give teachers the necessary basis to achieve these goals, a series of workshops on language resources and technologies was organised. The feedback of the teachers on the workshops is presented in the next section.

Preliminary Feedback from Teachers

From 2012 to 2014 a series of workshops on language technologies for primary and secondary school teachers, mainly teachers of Slovene, have been held at various locations around Slovenia. The 8 h workshops, funded by the Ministry of Culture of the Republic of Slovenia, focussed on presenting existing freely available language resources for Slovene, such as corpora, language tools, dictionaries and other reference works.[22] The Šolar corpus and the PGP were included in the workshop material for the 2013 and 2014 workshops. The workshop presenters reported of very positive feedback from the teachers; few teachers were initially sceptical, but mainly due to their lack of experience in using electronic resources and computers in general. However, after getting hands-on experience with the resources, scepticism was often

[22] The project website: http://ucitelji.sdjt.si/.

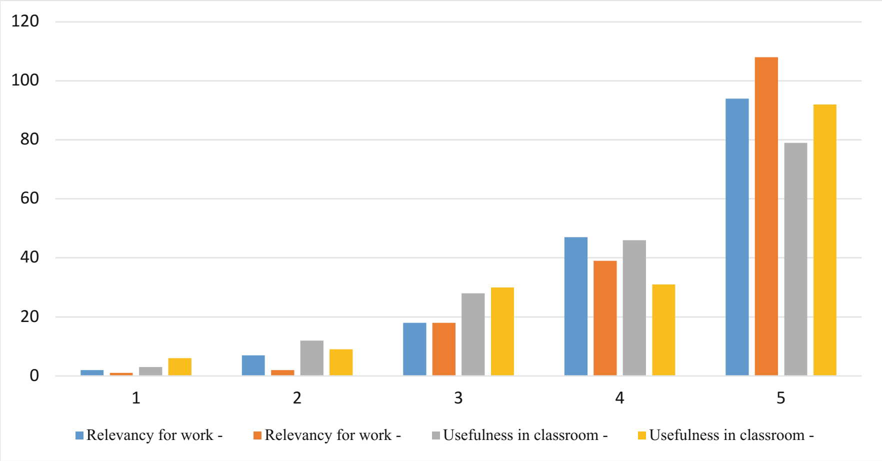

Fig. 7.5 Teacher evaluation of the Šolar corpus and the PGP

replaced with enthusiasm. The positive attitude of the teachers towards the Šolar corpus and the PGP was also confirmed by the results of the survey completed by the teachers after the workshops. The survey in 2013 was less detailed in so far that it did not ask teachers for their opinion on each of the resources presented; however, the teachers were given the option to name the resource that they thought was most useful for classroom work. The survey was completed by 208 primary school teachers, including 74 participants who teach Slovene in the last triad (12–14 years). Out of these, nearly a quarter (24 %) named the Šolar corpus as the most useful resource, while even more of them (36 %) thought the PGP to be the most useful.

A more detailed insight was provided by the survey in 2014, which was conducted among 168 teachers from different primary and secondary schools (Fig. 7.5). The participants had to evaluate the relevancy of the presented language resources for their professional (teaching) purposes. The grades ranged from 1 to 5, with 1 meaning that the resource is completely irrelevant and 5 meaning that the resource is highly relevant. The Šolar corpus was rated as relevant (with 4 or 5) by 84 % of the teachers, and the PGP by 88 %. Furthermore, the participants had to evaluate the usefulness of the resources for classroom use, again on a scale from 1 to 5. The Šolar corpus was evaluated as useful (with 4 or 5) by 74 % of the teachers, and the PGP by 73 %.[23] The results seem encouraging, considering the fact that the content on the PGP is still in its pilot version and thus rather limited in quantity. Nevertheless, this first feedback is very general, and hence a more detailed evaluation is planned.

[23] While interpreting these results, one has to keep in mind that teachers of different subjects were participating, as well as teachers of different grades. As a comparison: dictionaries of Slovene language SSKJ and SP 2001, which were among the highest rated resources, were recognised as relevant for work by 89 %, and useful in classroom by 84 % of the participants.

Conclusion and Future Work

In this chapter, we highlighted the potential of corpus-based language resources for language education in K-12, more specifically for L1 teaching. The basis of our study were two freely available online resources that were recently developed for teaching and learning Slovene as L1: the Šolar corpus and (utilising the corpus data) the Pedagogical Grammar Portal.

Despite the challenges presented in this chapter, the results seem promising. The Šolar corpus proved to be a highly suitable basis for the research of students' language competence and their language problems. The design of a specialised concordancer made the corpus data available not only to the research community, but also to the wider audience, such as teachers. The first feedback from the teachers has been very positive: not only did the teachers rate the corpus as useful for their work, they also recognised its value for the use in the classroom. Nevertheless, the initial enthusiasm was accompanied by remarks about the time-consuming use of the corpus for the preparation of teaching materials. These needs have been partially addressed by the creation of the Pedagogical Grammar Portal; however, further investigation into the attitude of the teachers towards the implementation of corpus data in the teaching process is needed. The second important task for the future is to increase the size of the Šolar corpus, ideally to around five million words, especially with the texts from the currently under-represented Slovenian regions. To accomplish this goal, the methodology would have to be improved as suggested in this chapter, especially to make the compilation process faster and more systematic.[24] Last but not least, we would like to supplement the corpus annotation with the fine-grained categories of language problems, as identified for the creation of the PGP. With the inclusion of these categories in the corpus XML file, the data will be available in the corpus concordancer, and consequentially generally accessible for the creation of materials for teaching Slovene.

The idea of the PGP was welcomed by the teachers as well, and its implementation into the teaching practice is at the time hindered primarily by the low number of chapters. For the future, an evaluation of the portal in an actual teaching environment is planned to determine how well the goals of the portal preparation have been achieved. After that, the pilot version of the portal will be upgraded and new chapters prepared. Our estimation is that for an applicative value in the classroom, at least 100 language problems need to be described (as mentioned before, almost 700 problems were identified in the corpus Šolar, though some of them will have to be described in more than one chapter). For the creation of the new material, the process of chapter preparation will have to be optimised, as the previously applied procedures have proven to be very time consuming. For example, the selection of

[24] At the end of 2015, a project aiming to at least double the size of the Šolar corpus was approved by the Ministry of Culture of the Republic of Slovenia. One of the main methodological changes is the collection of scans rather than photocopies of student texts—this will enable the development of digital repository of texts and thus facilitate the transcription process, as well as improve the archiving of the texts.

corpus examples for grammar exercises could be partially automatised, and in the second step conducted with the help of crowdsourcing. Secondly, further development of the portal's CMS could expedite the preparation of the online contents, as currently a lot of time is spent on manual formatting of specific elements. And finally, the creation of new content would have to be connected and synchronised with related corpus and lexicographic projects, e.g. the new dictionary of contemporary Slovene (Gorjanc, Gantar, Kosem, & Krek, 2015).

As it seems from the gathered experience, the ideal scenario would be to combine the compilation of corpora and development of didactic resources and materials into one seamless process. Such a process would consist of students writing essays on the computer, language technology tools would automatically identify errors for teachers, teachers would confirm the errors and their categorisation, the results (per text, student, class, region etc.) would be summarised and shared with other teachers and researchers, identified errors would be linked with resources with explanations and exercises (such as PGP), and ultimately, the teaching content would adapt to each student's individual needs and progress. There are early indications that we are not far from such process—the use of the digital media in schools is on the increase (e.g. in Slovenia, the 2015 PISA survey was for the first time conducted solely on computers), and there are websites such as Vocabulary.com and apps such as the Oxford Vocabulary Trainer (in testing at the time of writing) proving how different language technologies (automatic error detection, taggers, parsers etc.) can be combined to provide a more interactive and individual-oriented language learning experience. The only thing that the researchers and material developers need to ensure is that L1 language teaching and learning catches up with L2 and benefits from—as well as contributes to further progress of—these exciting new developments.

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Chapter 8
Tablet Use in Schools: Impact, Affordances and Considerations

Louis Major, Bjoern Haßler, and Sara Hennessy

Abstract The increased popularity of tablets in general has led to uptake in education. This chapter builds upon the past research and experience of the authors, in particular the findings of a critical systematic literature review that reports on the use of tablets in schools (see Haßler, Major & Hennessy, 2015). The aim of that review is to determine if, when and how using tablets impacts on learning outcomes: Do the knowledge and skills of students increase following the use of tablets for particular purposes, and, if so, what factors contribute to successful or unsuccessful use? Outcomes of the review enable us to reflect on the impact and affordances of using tablets educationally, and allow us to consider factors related to the successful integration of tablets in schools. This chapter provides information and advice for educators (including initial teacher educators) and school policy makers interested in the educational use of tablets. Overall, tablets have significant potential for enhancing learning—but, as with all technology—the most important element remains the teacher, and their classroom practice.

Keywords Tablet use • Schools • Today • K-12 learning environments • Impact of these digital tools • Student knowledge • Skills • Technology • Educators • ITE initial teacher educators • School policy makers • Teacher • Individual classroom practice

Mobile Learning and Tablet Computers

Since the early 1980s schools, colleges and universities have experimented with technology for learning (Sharples, Taylor, & Vavoula, 2010). As the adoption of mobile technologies in education becomes more widespread, research is starting to demonstrate the value of incorporating such devices in teaching (Hwang & Wu, 2014; McFarlane, Triggs, & Yee, 2008). Mobile devices can enhance, extend and enrich the concept of learning in a number of ways (Traxler & Wishart, 2011): (1)

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contingent mobile learning and teaching (where learners can respond and react to their environment and changing experiences, and where learning and teaching opportunities are no longer predetermined); (2) situated learning (where learning takes place in surroundings that make it more meaningful); (3) authentic learning (where learning tasks are meaningfully related to immediate learning goals); (4) context-aware learning (where learning is informed by the history, surroundings and environment of the learner); and (5) personalised learning (where learning is customised for the interests, preferences and capabilities of learners). Cost, adaptability and scalability are among motivations often cited for using mobile technologies to support learning (Ozdamli, 2012). Greater affordability of such technology, along with the rapid development and expansion of wireless internet access, has resulted in mobile learning becoming increasingly prevalent (Hwang & Tsai, 2011; Martin & Ertzberger, 2013). This has led some commentators to predict that by 2020 every student in the USA, across all grades, will have access to a mobile computing device 24/7 (Norris & Soloway, 2015). A range of different mobile technologies have been used educationally (Frohberg, Göth, & Schwabe, 2009; Kearney, Schuck, Burden, & Aubusson, 2012; Naismith, Sharples, Vavoula, & Lonsdale, 2004; Traxler, 2010), including specialised handheld devices such as data loggers, phones and smartphones, low-power computers such as the Raspberry Pi,[1] as well as tablets.

Tablets, sometimes referred to as tablet computers, feature the integration of several components and sensors (e.g. GPS, built-in camera) within a single relatively light-weight device, typically with a touch screen, no built-in keyboard or mouse, (at least nominally) good battery life and at a comparatively low price compared to 'traditional' computers. Tablets became commercially available in 2002 (El-Gayar, Moran, & Hawkes, 2011) and, by 2009, around 14 million had been sold worldwide (Ozok, Benson, Chakraborty, & Norcio, 2008). With the launch of the first Google Android-based tablets (2009) and the Apple iPad (2010), the popularity of tablets increased (Geyer & Felske, 2011). Sales of tablets have grown greatly since then, and in 2015 a projected 321 million tablets will be sold, overtaking sales of 'traditional' PCs for the first time.[2] By 2018, the number of tablet users worldwide has been predicted to stand at 1.43 billion.[3] The popularity of tablets has led to interest in educational applications, particularly in schools. As with many digital classroom resources, the use of tablets has the potential to enhance learning (Kim & Frick, 2011), for instance contributing to raised motivation (Furió, Juan, Seguí, & Vivó, 2015), knowledge acquisition (Lai, Yang, Chen, Ho, & Chan, 2007), and enquiry-based learning (e.g. Haßler et al., 2011; Haßler, Hennessy, & Cross, 2014; Hennessy, Haßler, & Hofmann, 2015a, 2015b).

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[1] http://www.raspberrypi.org.

[2] Forecast: *PCs, Ultramobiles, and Mobile Phones, Worldwide, 2011–2018*, 2014 Update Retrieved October 09, 2015, from http://www.gartner.com/document/2780117.

[3] *Tablet Users to Surpass 1 Billion Worldwide in 2015*. Retrieved October 09, 2015, from http://www.emarketer.com/Article/Tablet-Users-Surpass-1-Billion-Worldwide-2015/1011806.

This chapter builds upon the past research and experience of the authors, in particular the findings of a critical systematic literature review that reports on the use of tablets in schools (see Haßler, Major, & Hennessy, 2015). The aim of this review was to determine if, when and how using tablets impacts on learning outcomes: *Do the knowledge and skills of students increase following the use of tablets for particular purposes*, *and*, *if so*, *what factors contribute to successful or unsuccessful use*? Outcomes of the review enable us to reflect on the impact and affordances of using tablets educationally, and allow us to consider factors related to the successful integration of tablets in schools.

The review used the systematic review methodology, informed by Kitchenham and Charters (2007) and the EPPI-Centre (2010), and focused on literature reporting the use of tablets by primary and secondary school children. It built on and advanced previous research through considering the literature on actual learning outcomes rather than just motivational affordances associated with using tablet technology. Systematic reviews are trustworthy, rigorous and auditable tools (Kitchenham, 2004) that allow existing evidence to be collected and summarised and enable identification of gaps in current research (Kitchenham & Charters, 2007). A mixed search strategy, involving manual and automated searches of electronic resources, was undertaken in May/June 2014. Technology- and education-based resources were searched. Inclusion and exclusion criteria ensured that only relevant literature was included. Each study in the final set was also assessed for its quality based on a set of guidelines produced to guide the quality assessment process. This quality assessment involved assessing studies according to their methodological trustworthiness (non-review specific; the trustworthiness of a study's results based on an evaluation of the research approach used) and relevance to the review (review specific; relevance of a study for determining whether the knowledge and skills of students increase following the use of tablets). Several stages of screening were used to identify studies: (1) *Initial Search* (i.e. implementing the search strategy, identifying potentially relevant literature based on analysis of titles and abstracts)—103 studies progressed to Stage Two; (2) *Detailed Examination* (i.e. reading the full text of identified studies, applying the inclusion criteria and checking reference lists for other potentially relevant work)—33 studies progressed to Stage Three; (3) *Data Extraction and Quality Assessment* (i.e. detailed analysis and quality assessment of studies identified as relevant)—drawing on the 33 studies identified.

The final set of 33 studies included in the review, the reported findings of which we draw on in this chapter, are varied in their research scope: using a number of methodological approaches; involving diverse numbers of participants aged 5–20; employing different tablets (including different brands); involving individual (one-to-one), shared, (i.e. many-to-one) and mixed (i.e. individual and shared) use of tablets by students. Together, the current chapter and the systematic review help to address the need for guidance arising out of the growing interest in the meaningful use of tablets for education in schools (Johnson, 2014).

The Impact of Tablet Use on Students' Subject Knowledge and Skills

Fewer studies focus on learning gains compared to other aspects of tablet use (e.g. motivational gains; Haßler, Major, & Hennessy, 2015). However, within the studies focussing on learning gains, tablets are largely reported as having a positive impact on student learning. Indeed, positive learning outcomes have been reported following the use of tablets to support activities related to science (Furió et al., 2013; Liu, Lin, & Paas, 2013, 2014; Liu, Lin, Tsai, & Paas, 2012; Ward, Finley, Keil, & Clay, 2013), social studies (Lin, Wong, & Shao, 2012) and mathematics (Riconscente, 2013). In addition, positive outcomes are reported in teaching multiple subjects (Cumming, Strnadová, & Singh, 2014; Ferrer, Belvís, & Pàmies, 2011; Goodwin, 2012; Heinrich, 2012; Li, Pow, Wong, & Fung, 2010), and assisting students with special educational needs (Fernández-López, Rodríguez-Fórtiz, Rodríguez-Almendros, & Martínez-Segura, 2013; Gasparini & Culén, 2012; McClanahan, Williams, Kennedy, & Tate, 2012; Miller, Krockover, & Doughty, 2013). Examples of specific topics where knowledge and skills improved include those relating to the water cycle (Furió et al., 2013), plant morphology (Liu et al., 2012, 2013, 2014), fractions (Riconscente, 2013), food-chain dynamics (Ward et al., 2013) and financial management and economics (Lin et al., 2012). Below, details of three studies (all of which were determined to be of high trustworthiness and relevance during the quality assessment undertaken as part of the systematic review) are provided to illustrate some of the ways in which tablets have successfully helped to support learning.

Case Study of Practice: Reinforcing Knowledge of the Water Cycle: Furió et al. (2013)

Investigated differences between a mobile phone and tablet, in terms of size and weight, as platforms for an educational game designed to reinforce children's knowledge about the water cycle. The intervention was developed based on controversial educational theory (Gardner's theory of Multiple Intelligences and Kolb's Learning Styles). Seventy-nine Spanish students, aged 8–10 years old, participated during a 1-day session. The game included multiple interaction forms (touchscreen and accelerometer) and combined augmented reality (AR) mini-games with non-AR mini-games. No significant differences were found between the two mobile devices and positive results were found for both.

Case Study of Practice: Supporting Social Studies Lessons: Lin et al. (2012)

Investigated the effect of using collaborative concept mapping activities, using the Group Scribbles system, in Social Studies lessons. Based in Taiwan, and involving 64 students aged 12, tablets facilitated learning in both one-to-one and many-to-one settings over a period of around 1 month. Members of each one-to-one group carried out their discussion and posted ideas or concepts to their Group Board, using their individual tablets. Conversely, having only one shared tablet, each many-to-one group identified a team member to assume the responsibility of creating and editing the concept map, while the rest provided only verbal opinions. In both one-to-one and many-to-one settings students demonstrated learning gains. While one-to-one groups demonstrated more consistency in group participation, improved communication and interaction, however, the many-to-one groups instead generated superior artefacts due to group discussion.

Case Study of Practice: Strengthening Students Knowledge of Fractions: Riconscente (2013)

Investigated whether an iPad-based fractions game, Motion Math, improves student's fractions knowledge and attitudes. Motion Math intends to help children strengthen their understanding of the relationship between fractions, proportions, and percentages to the number line and involves the "player" physically tilting a mobile device (using the accelerometer) to direct a falling star to the correct place on the number line at the bottom of the screen. This US-based study, involving 122 fourth grade students (aged 9–10), found students' fractions test scores improved an average of 15 % over a 1-week period, representing a significant increase compared to a control group. Children's' self-efficacy for fractions, as well as their liking of fractions, each improved an average of 10 % also.

We note, however, that the literature does not exclusively report positive learning outcomes. Indeed, neutral outcomes are reported by research involving the use of tablets to support activities in literacy and reading (Huang, Liang, Su, & Chen, 2012), mathematics (Carr, 2012), basic life support and cardiopulmonary resuscitation skills (Iserbyt, Charlier, & Mols, 2014), and science (laboratory simulation software for conducting experiments; Nedungadi, Raman, & McGregor, 2013). Additionally, no significant difference was found with regard to reading speed or level of comprehension when students' electronic text reading performance with tablets was compared to printed books (Dundar & Akcayir, 2012). Other research reports negative or neutral impact on reading comprehension following use of tablets three times a week, for 45–60 min a time, over a period of several weeks (Sheppard, 2011). Teachers also found learning outcomes to be inferior where tablets were used to support collaborative tasks that aimed to enhance student creativity and writing skills, compared to non-technology based tasks that were completed during previous academic years (Culén & Gasparini, 2011).

Across these studies there is no single overarching explanation for the neutral or negative learning outcomes. However, it is interesting that such outcomes were not considered as being linked to the nature of tablets. Indeed, studies suggest that students: had positive attitudes and enjoyed interacting with tablets (Dundar & Akcayir, 2012; Huang et al., 2012; Nedungadi et al., 2013); did not have difficulty adapting to the use of tablets (Dundar & Akcayir, 2012); and found tablets to be convenient and usable (Huang et al., 2012). Furthermore, studies reporting neutral findings do not dismiss the use of tablets in the classroom but rather encourage educators, school leaders and school officials to further investigate the potential of such devices (e.g. Carr, 2012).

Affordances of Tablets That Contribute to Improving Learning

In this section we consider the various affordances of tablets which may be relevant factors contributing to a positive impact on student learning outcomes.

High usability and integration of multiple features within one device. Use of built-in cameras (Cumming et al., 2014), accelerometers (Furió et al., 2013; Riconscente, 2013), microphones (Miller et al., 2013) and easy access to tools such as dictionaries and screen readers (Cumming et al., 2014) within a single device, has the potential for supporting learning and facilitating a diverse range of educational experiences (Goodwin, 2012). Sometimes students do not require an introduction on how to use tablets because they have prior experience (Cumming et al., 2014). Training sessions can, however, help them become familiar with tablets (Fernández-López et al., 2013).

Easy customisation and supporting inclusion. Adjusting text colour (Cumming et al., 2014) and size (Dundar & Akcayir, 2012), as well as using synthetic voices and screen viewing modes (portrait, landscape, zoom; Gasparini & Culén, 2012), allows learners to adapt tablet-based resources to their individual needs. Tablets can be useful to all students, and in environments where they are routinely used by all, stigmatisation commonly associated with bespoke assistive technologies is minimised, raising academic confidence (Gasparini & Culén, 2012; Miller et al., 2013). Tablets can also be used in implementing personalised learning environments, tracking learning processes in a manner potentially superior to other methods (Huang et al., 2012).

Touch screen. Displays can provide rich and more vivid pictorial representations than traditional paper books (Cumming et al., 2014), and tablet displays in particular can be more user-friendly and ergonomic than bulkier display types (Dundar & Akcayir, 2012). Moreover, manipulative touch screens can promote the use of several modalities, including visual and tactile/kinaesthetic, and this may facilitate engagement in a way that typical classroom experiences do not (McClanahan et al., 2012).

Availability and portability. Tablets can create immersive learning experiences with elements that are arguably similar to those at museums or historical sites (i.e. environments that are not always accessible due to geographical, practical or financial constraints; Cumming et al., 2014). The potential of an augmented reality approach using tablets has been likened to children exploring the world and discovering new elements with a magnifying glass (Furió et al., 2013). Tablet devices are easy for students to carry (Dundar & Akcayir, 2012), and this mobility can enable situated as well as anytime-anywhere learning due to timely and easy access to information and appropriate learning aids such as translation tools (Fernández-López et al., 2013; Heinrich, 2012). Students were also found to have strong awareness in organising and self-regulating their learning following the use of tablets (Li et al., 2010).

In addition to the above factors, applications designed to run on tablets may be simpler and more "intuitive" to use than their counterparts used with technologies such as laptops (running "traditional" computer programs) because tablet-based applications are designed to work with a range of screen sizes and as they often lack the notion of opening and closing applications, and, in many cases, without the need to explicitly save data. This may have both educational advantages (e.g. less complexity leading to faster learning curves) and disadvantages (e.g. reduced functionality, less customisability). Other factors include that tablets are increasingly designed to work with cloud storage (facilitating the storage and exchange of data) and are available at price points that make them very competitive to comparable technology (Johnson, 2014). Indeed, one of the advantages of lost-cost technologies is that they can support all students and thus meet specific needs without stigmatisation, which may not necessarily be the case with 'traditional' assistive technologies.

How do the affordances of tablets compare to those of other devices? Some research hints at the possibility that introducing tablets is reducing the use of desktop computers in computer labs, but only inasmuch as this use was to do with basic activities (such as looking up information and taking pictures: Chesterton Community College, 2014). Unsurprisingly, certain technologies are more appropriate for particular tasks than others and this is also true when considering uses for tablets: e.g. keyboards, larger screens and specialised software (perhaps only available for certain operating systems) may be needed to support specialised tasks such as extensive writing, mathematical constructions and computer programming.

Considerations for the Integration of Tablets in Schools

Infrastructure, Technology Management and Professional Development

Effective technology management, underpinned by sound change management principles, is critical to the successful introduction of tablets (Heinrich, 2012). An existing technical team may successfully play the role of a change agent

(Li et al., 2010). Cultivating a supportive school culture that fosters collegiality and teacher empowerment at different levels can be pivotal for the effective introduction of tablets (ibid.). Teachers have identified benefits for their workload following tablet implementation, as lessons had greater variety and pace, in addition to cost savings such as reduced photocopying costs (Heinrich, 2012).

It is important that schools looking to invest in tablets ensure that they have a robust wireless infrastructure, with sufficient capacity to accommodate entire class sets of tablets connecting simultaneously (Sheppard, 2011; Ward et al., 2013). The model and operating system of the tablet selected must be taken into account as certain models may be better suited for schools who wish to exert full control over content and exploit open-source options (Sheppard, 2011). A related issue includes new tablet models being released midway through implementation (Culén & Gasparini, 2011), and an occasional need to purchase supplementary technology such as VGA display adapters (ibid.). Other factors identified include the difficulty younger children can experience in handling tablets, although external cases (with handles) may help to remedy this (Furió et al., 2013). Another important question is whether students have access to tablets outside school: Carr (2012) suggests that giving students continuous access to technology outside of school may help to improve learning outcomes.

While we did not identify a research study which reports that the implementation of tablets failed as a result of ineffective project management, poor management and technological issues have led to the collapse of similar initiatives previously.[4] There are high profile schemes, such as the $1 billion Los Angeles School District iPad scheme,[5] that have been affected by a number of significant challenges. The development of rigorous contingency plans is, therefore, essential from the outset for school-based tablet projects. Schools looking to invest in tablets should also acknowledge that educational technologies are most effective when there is an holistic strategy to integrate digital and non-digital resources, and that learning is improved when a school's infrastructure facilitates the use of a new technology (Diaz, Nussbaum, & Varela, 2014).

Finally, schools ought not to assume that teaching staff are ready to effectively use tablets from the outset (Melhuish & Falloon, 2010), but should pro-actively create adequate opportunities for professional development. A lack of relevant training, a shortage of technical support and the absence of the tablets from school policy can prevent staff from using tablets on a regular basis (Oliviera, 2014). Often where induction is provided it is usually minimal and technically focussed. It is, therefore, essential that technical support is provided particularly to teachers charged with introducing tablets. The fact that new educational interventions require time to

[4] *Why one New Jersey school district killed its student laptop program*. Retrieved October 09, 2015, from http://arstechnica.com/tech-policy/2014/07/why-one-new-jersey-school-district-killed-its-student-laptop-program.

[5] *US schools seek refund over $1.3bn iPad project*. Retrieved October 09, 2015, from http://www.bbc.co.uk/news/technology-32347651.

become embedded in classroom practice must also be appreciated, and school leaders should acknowledge that the benefits of a new technology are not immediate (Carr, 2012; Silvernail & Gritter, 2007).

Pedagogy and Instructional Design

Pedagogical practice is not an outcome of technology, and does not change as a result of introducing new technology (Osborne & Hennessy, 2003). On the contrary, the power of using technology in the classroom relies on the premise that technology is integrated into the existing pedagogy (Hennessy & London, 2013).

Tablets can simulate real-world situations such as laboratory experiments, and in the process potentially allow a greater degree of enquiry, as tasks can be repeated many times (Nedungadi et al., 2013). For practitioners, supports such as dictation software leave less to interpretation and can also enable more accurate assessment (Miller et al., 2013). However, other studies report distraction as tablets can add additional layers of complexity (due to technical problems with tablet and applications used) compared to traditional means of completing similar tasks (Culén & Gasparini, 2011). The addition of entertaining features to increase the interest of a lesson may ultimately distract learners and lead to poorer learning outcomes (Iserbyt et al., 2014).

The use of mobile technologies in conjunction with real objects in a physical environment may represent a promising approach for learning environments. It is clear that digital cues can be used to increase the effectiveness and efficiency of such environments by supporting learners to mentally integrate different spatially separated sources of information (Liu et al., 2013). There are nevertheless cognitive challenges in mobile device-based learning environments that need to be considered in order to make those environments effective (ibid.).

The utility of a tablet in providing novel lessons is clearly limited by the availability of suitable content (Ward et al., 2013) and issues with software can negatively impact upon students' work (Culén & Gasparini, 2011). Certain constraints of tablet platforms imposed by manufacturers, such as the inability to use Java and Flash-based web content on the Apple iPad, have also been found to have a limiting effect (Ward et al., 2013). A rethink of the pedagogical approach is also necessary in order to take into account new issues arising during multimodal interactions and collaborations between students sharing tablets (Culén & Gasparini, 2011).

Both boys and girls indicated that they participated more in learning tasks when tablets were used (Ferrer et al., 2011), and enhanced levels of collaborative working were evident (Heinrich, 2012). The use of tablets resulted in an increase in students sharing their digitally produced work (including via interactive whiteboards) and provided opportunities for teachers to offer ongoing feedback and to collect cumulative assessment data (Goodwin, 2012). Teachers were able to use tablets to modify and redefine student learning by employing transformative pedagogical models, and the technology acted as a catalyst for more creative pursuits and exploration of new pedagogical approaches (Goodwin, 2012). The Technological Pedagogical Content

Knowledge (TPACK) framework (Koehler & Mishra, 2009) is relevant to tablet use, and teachers have successfully applied their TPACK to choose how to implement tablet-based learning (Cumming et al., 2014). Learner-centred approaches may be a particularly valuable strategy for students who learn from multimedia content on tablets (Iserbyt et al., 2014).

It has been suggested, partly due to technical considerations (synchronising content and recharging batteries), that tablets may be best suited for individual rather than collaborative use (Sheppard, 2011). The customisability of tablets can also cause problems in shared use situations, as the ability to change font and font size can alter page numbers which makes referring back to earlier pages problematic (ibid.). Some students are reluctant to share 'their' tablet with fellow learners (Culén & Gasparini, 2011). In another study, students working in groups of two to three all responded that they felt that they were able to spend enough time using the tablet, although a proportion of students in groups of four responded that they would have liked more time to use the device (Ward et al., 2013).

It is sometimes taken for granted that the one-to-one setting is most effective, rather than considering a variety of settings. In our systematic review, only one study explicitly considered the differences between one-to-one and many-to-one use of tablets (Lin et al., 2012), indicating that using tablets can improve learning outcomes in both settings. Importantly though, in the one-to-one setting there is no competition for tablets among students, and in the studies reviewed there was consistently high group participation, improved communication and interaction. However, the many-to-one groups exhibited more peer collaboration and generated superior artefacts as all the notes were well discussed among the group members (ibid.). Because of the high connectivity and the capability of co-construction supported by tablet technology, students' roles, participation and contributions within a group were found to be more equal in the tablet class when compared to the pattern of collaboration found in a non-tablet class (Li et al., 2010).

Another factor that is not investigated is screen size: 7″ vs. 10″, or even larger sizes (such as 13″). We would expect smaller tablets to be more suited to personal tasks, and larger tablets to be more appropriate for collaborative working (e.g. facilitating group work by jointly working on a tablet in the centre of a table). Clearly, the characteristics of the device need to be such that they support learning intentions (in one-to-one and many-to-one settings, which can both represent effective strategies, depending on the task). However, each tablet feature (as well as the overall number of tablets) also has cost implications.

While evidence is limited on which approach facilitates the greatest learning gains, specific affordances available with tablets (such as portability and typically long battery life) potentially make them well suited for supporting collaborative activities. For tablets to be used effectively in shared settings, however, constraints may have to be overcome. Issues identified include problems synchronising content (potentially because of a limited number of user accounts), in addition to factors related to customisability (such as modifying elements like font type). Tablets may enable a greater degree of enquiry as certain learning tasks and situations (e.g. a laboratory-based chemistry experiment) can be varied and repeated a number of times.

Conclusion and Outlook

Overall, favourable results are reported in the literature regarding the impact of tablets on learning outcomes. There is little doubt that in principle, tablets—like other educational technologies—can viably be used to support school children of all ages to learn in a variety of settings. Several affordances appear to be specific to tablets: the integration of multiple features within one device (including multiple sensors), easy customisation and portability (which can also be supportive for ubiquitous use supporting inclusion without stigmatisation), and high quality touch interfaces (allowing for manipulation of objects).

We undertook the review on which this chapter is based expecting existing research to focus on learning activities drawing on the specific affordances unique to tablets, such as the availability of accelerometer (e.g. for multimodal interaction; Furió et al., 2013; Riconscente, 2013) and GPS sensors (e.g. to enrich environmental data logging). We also anticipated that portability would lead to greater situated learning and it is surprising that there is not more emphasis on using tablets for investigative work, including project work outdoors (using sensors for mapping and measurement, i.e. location, velocity, acceleration of objects). While few studies have investigated these affordances yet, this is not to say that such features cannot successfully be used to support the learning of school age students.

Tablets could be considered like any other resource that might be used in the classroom: If used appropriately, this can lead to learning gains. Also, tablets are likely to be best used in conjunction with other resources (in the widest sense, including digital and non-digital). There is strong evidence for the benefits of collaborative work (Higgins et al., 2013), and it would seem prudent to look at how tablets could support such established practices. While evidence is limited on which approach (i.e. students working individually or in a group) facilitates the greatest learning gains, specific affordances available with tablets potentially make them well suited for supporting collaborative activities.

With regard to physical affordances, overall we conjecture that smaller (7″) tablets may lend themselves more to individual activities (e.g. reading), while larger tablets (10″–13″) may be much more suitable for supporting group work. Moreover, while for some activities "integrated" devices such as tablets may be beneficial (such as supporting student working outdoors), for other activities a component-based system (such as a Raspberry Pi with the new low-cost touch screen) may be more advantageous (e.g. for supporting physical computing). Initially designed as single-user devices, tablets have a large market share, and so costs for educational use (including informal educational use) are driven down, perhaps even more so than the overall affordability of other devices. However, the consumer-driven nature also entails frequent software updates, which are potentially disruptive to learning environments. In order to exploit the new opportunities for student-led inquiry-based learning that are afforded by tablets, investment in teacher development is essential. Use of peer support may help to keep costs low, particularly where colleagues have sufficient expertise and experience, or where there is an inquiry culture among staff in the school.

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Chapter 9
EUFolio: A Classroom ePortfolio Pilot Project

Ben Murray and Sinéad Tuohy

Abstract This chapter details the participation of Ireland as one of seven European countries in the *EUfolio Classroom ePortfolios* project. This was a 2-year project (May 2013–May 2015) funded by the European Commission under the framework of the Lifelong Learning Programme (KA1—Implementation of the European strategic objectives in Education and Training). The idea for the EUfolio project came from the ICT and Education Working Group created under the *Education and Training 2020* programme, a network that includes 24 Ministry of Education representatives. A number of members came together with a common interest in implementing ePortfolios at national level leading to the inception of this initiative. Ireland was one of seven European countries that participated in this ePortfolio project, which had a focus on designing and testing innovative ePortfolio models that would inform the implementation of innovative learning environments across Europe.

This chapter focuses on the experiences of the Irish pilot, and demonstrate examples of where ePortfolios were used to promote a collaborative approach to assessment, where the interactions between teacher and student opened up the learning process to become a reciprocal and dialogic activity; a more supportive and inclusive culture where formative practices in the classroom could flourish.

Using an ePortfolio allowed students to show achievements in a variety of ways, give a clear vision of their learning journey thus far, and provide a platform for peer and self-assessment. All these components can contribute to ensuring a learning and assessment system that places students at the centre of the learning process, accommodates the diverse needs of learners, impacts positively on student motivation, and engages students in experiences appropriate to *their* twenty-first century.

Ben Murray and Sinéad Tuohy are seconded second-level teachers who were EUfolio project researchers and mentored Irish schools as part of the EUfolio Classroom ePortfolios project. Their research interests include ongoing assessment, the disruptive use of technology and developing teacher collaboration.

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Keywords European countries • *EUfolio Classroom ePortfolios* project • European Commission • Lifelong learning • ePortfolios • Collaborative approach • Assessment and learning • Learning process • Supportive culture • Formative practices • Classroom

Introduction

A recent OECD (2015) report claims that despite the "pervasiveness of ICT in our daily lives, these technologies have not been as widely adopted in formal education". The report expresses concern that:

> As long as computers and the Internet continue to have a central role in our personal and professional lives, students who have not acquired basic skills in reading, writing and navigating through a digital landscape will find themselves unable to participate fully in the economic, social and cultural life around them (2015, p. 15).

These "digital landscapes" that surround students are not flat or even with unspoilt vistas to a defined destination. They are unpredictable, with twists and turns and unexpected obstacles and challenges. Students need experiences and skills that will prepare them for these unexpected challenges and allow them to navigate their particular landscape with confidence. The provision of these experiences and the development of these skills was central to the exploration and experimentation process of this project. The aim was to design and test innovative ePortfolio models that could inform and support the implementation of innovative learning environments using ICT in post-primary schools across Europe. It was envisaged that these environments could support students working with and through technology and working with peers and mentors in ways that would stimulate new pedagogies and new approaches to learning.

Partnership

The EUfolio consortium brought together 14 partners from seven European countries (Austria, Bulgaria, Cyprus, Ireland, Lithuania, Slovenia and Spain) in a collaborative research and implementation process; establishing a network of policy experts, researchers, educational experts and practitioners.

The main focus of the project was on five national pilot exercises in Ireland, Slovenia, Lithuania, Cyprus and Spain. These pilots were to facilitate experimentation and engagement with ePortfolios and focus on the learning from the practical implementation of ePortfolios in schools—from which policymakers and other educational partners could draw valuable real-world lessons on deepening the use of ICT in teaching, learning and assessment.

The project had a strong commitment to developing a sustainable impact on the professional development of participating teachers and contributing to the progress and findings of other international ePortfolio networks and research partnerships. The partnership aspired to produce support materials and policy documents that would provide guidance and advice for schools and national policy makers in how best to integrate portfolios into teaching and learning. These included a review of existing policy and practice in the digital portfolio arena, a process specification, teacher CPD resources, school case studies with exemplar portfolios and an online peer-to-peer network that would serve to support teachers and those in policy both during and beyond the life span of the project.

Piloting in Schools

In all, 72 schools from the five piloting countries participated in the project during 2014. The pilot implementation was carried out in two phases: Phase 1, January to May 2014; and Phase 2, September to December 2014. When considering the platform to be used,

> typical user requirements (should) include an authoring environment, facilities for sharing and publishing, tools for action planning, discussion and feedback, space for storing digital artefacts, and opportunities to link to other systems where data of importance to the learner is located (JISC, 2008, p. 6).

Schools were given access to two platforms which met these requirements; Mahara and a Microsoft O365 portfolio solution.

Mahara is an open-source ePortfolio web platform, which allows users to create webpages and journals, upload files, embed web 2.0 tools, engage in discussion forums, create groups and demonstrate their accomplishments and achievements. Microsoft developed an ePortfolio solution that was based on SharePoint, OneDrive and Office 365. Students and teachers could use their SharePoint/Microsoft accounts in order to create their own personal portfolio space and interact and collaborate with others.

See the table below for a detailed account of the overall pilot figures (Table 9.1).

Table 9.1 Number of participating schools per piloting partner country

Country	Number of schools	Number of piloting teachers	Number of students
Cyprus	6	18	342
Ireland	26	50	1325
Lithuania	10	20	441
Slovenia	15	73	807
Spain	15	33	1183
Total	72	194	4098

Economou, A., Avraamidou, A. (2015). EU Classroom ePortfolios Pilot Evaluation Results (p. 23).

Irish Context: Reform of Junior Cycle Education

In 2012 the Irish government published The *Framework for Junior Cycle* (DES, 2012[1]) in response to a rhetoric for change that emerged from "research evidence, public and political consensus, and professional concern" (NCCA, 2011). What was evident from the rhetoric was a concern that the learning experiences for 12–15 year-old students is dominated by a state examination at the end of third year, which emphasises rote learning and rehearsing of questions. This research also evidenced the poor quality of student engagement across junior cycle and an absence of skills development as a result of an overcrowded and content dominated curriculum (NCCA, 2011; Smyth, Dunne, Darmody, & McCoy, 2007; Smyth, Dunne, McCoy, & Darmody, 2006; Smyth, McCoy, & Darmody, 2004).

This new Framework is designed to place the student at the centre of the learning process and envisages a curriculum that allows for new ways of learning and a broader range of skills to be appropriately assessed. A new approach to teaching, learning and assessment is advocated which provides a valuable opportunity to embed classroom-based assessment and formative assessment, while recognising the role of external assessment. The implementation of the Framework enables schools to consider their understanding of how teaching, learning and assessment practices should evolve to support the delivery of a "quality, inclusive and relevant education" that will meet the needs of all junior cycle students, both now and in the future (p. 6). Thus, the Framework proposes an assessment system that "emphasises both the process and the product of learning" and favours strengthening the role that formative assessment can play, to ensure that "assessment takes place as close to the point of learning" as possible (p. 18).

The *Framework for Junior Cycle* outlines the curriculum and assessment arrangements that provide students with learning opportunities that promote a balance between understanding subject knowledge and developing a wide range of skills and abilities. These arrangements focus on active and collaborative learning where students are enabled to use and analyse information in new and creative ways, to investigate issues, to explore, to think for themselves, to be creative in solving problems and to apply their learning to new challenges and situations.

The 2012 Framework is underpinned by eight principles, 24 Statements of Learning that describe what students should know, understand, value and be able to do at the end of junior cycle; and six key skills that are required for successful learning by all students. These key skills are underpinned by literacy and numeracy skills, which are outlined in the *National Literacy and Numeracy Strategy* published in 2011. These six Key Skills are identified as the types of skills that will provide for

[1] This *Framework for Junior Cycle* (2012) has since been revised with *A Framework for Junior Cycle* 2015. It can be accessed here: https://www.education.ie/en/Publications/Policy-Reports/Framework-for-Junior-Cycle-2015.pdf.

successful learning by students "*across the curriculum and for learning beyond school*" (DES, 2012, p. 9). The six key skills[2] are:

- Managing myself
- Staying well
- Communicating
- Being creative
- Working with others
- Managing information and thinking.

They link to the skills required at senior cycle and those developed for early childhood and primary education. They also link to other similar frameworks in the international domain such as the ATC21s model, which defines ten twenty-first century skills into four broad categories (http://www.atc21s.org/), and the European Framework's eight competences for lifelong learning (http://keyconet.eun.org/key-competences). Each of the six key skills consists of elements that further expand and describe the opportunities for the development of the skills. Each key skill has a discrete technological element in recognition of the need to embed technology in the educational experience of Irish students.

As part of the subject developments advocated in the *Framework for Junior Cycle*, it is proposed that for all subjects there will be two school work components[3] that will be assessed by the class teacher and contribute to a final certification. This school-based component may include assignments, projects, case studies, performances, oral activities, written pieces and tests of different kinds.

Focus of the Irish Pilot

When taking account of the contexts outlined above, the focus of the work of the Irish pilot was threefold. Firstly, we wanted to explore how the use of ePortfolios could support the delivery of curriculum content in innovative and alternative ways, with a particular emphasis on pedagogical approaches to foster **formative assessment** practices. In particular the intended focus was placed on approaches to delivering quality feedback, fostering collaborative environments where peer and self-assessment were championed, and opportunities for regular and meaningful student reflection.

A second facet of the project was concerned with building the technical capacity of both teachers and students and investigating the **digital storage** functionality of the ePortfolio. It is envisaged that the school work component outlined above will lend itself very well to the use of electronic portfolios, as students are expected to present a selection of their work, and are encouraged to do this in a variety of media formats. As well as investigating the storage capacity of the ePortfolio, we were

[2] The revised Framework for Junior Cycle 2015 (p.13) now includes eight key skills. https://www.education.ie/en/Publications/Policy-reports/Framework-for-Junior-Cycle-2015.pdf.

[3] Revised in *Framework for Junior Cycle 2015* and renamed Classroom Based Assessment(s) https://www.education.ie/en/Publications/Policy-Reports/Framework-for-Junior-Cycle-2015.pdf.

keen to focus on the challenges involved in working in a digital environment and to investigate the technical hurdles teachers and students need to overcome in order to work successfully with ePortfolios.

The third strand of our focus centred on gathering data on the opportunities for twenty-first century skills (**key skills**) and competencies to be developed in our students. Many of the elements of the key skills lend themselves to the portfolio environment and can be embedded in the teaching, learning and assessment activities throughout the pilot phase.

As the Irish partnership represented a number of partners within the education system, including those with responsibility for developing curricula and those who provide support to teachers, it was envisaged that the implementation and findings of the EUfolio project would provide a very solid foundation for articulating policy and recommending best practice across the second level system nationally.

All junior cycle subjects are being reviewed and specifications for these subjects will now be outcomes-based and introduced on a phased basis from 2014 to 2020. The first subject to go through the review process was English and as a result this was chosen as one of the points of concentration for the EUFolio initiative. The other subject that was chosen was Design Communication Graphics (DCG), a senior cycle subject that already has strong ties to technology use and where the ePortfolio model was a natural fit. 26 schools were chosen as the pilot schools. These were selected by the project team based on the following factors to ensure a cross section of school type:

- geographical spread
- small/large
- urban/rural
- gender—(boys school/girls school/mixed school)
- Irish speaking schools
- adequate broadband/wifi.

In total 50 teachers were involved in the subject areas of both English and DCG. There were over 1300 students involved in the project, with the majority of English students being in first year or second year (12–15 years old) while the DCG cohort was made up of senior cycle students (16+). Within the pilot, 25 schools engaged in the implementation within their English class with one school focusing on DCG.

Exploring ePortfolios

As a core element of the EUfolio project, partners conducted a *Policy and Practice Review* of ePortfolios in education, including a review of related literature. These reviews revealed a myriad of roles and functions the portfolio potentially supports. These are explored in detail in this section, and provided the framework to develop the EUFolio implementation model.

Abrami and Barrett (2005) define ePortfolios as

> a digital container capable of storing visual and auditory content including text, images, video and sound … designed to support a variety of pedagogical processes and assessment purposes (p. 2).

This definition emphasises the potential of the ePortfolio to deal with multi-modal text, including images, embedded links, videos and sound files, which is essential for the twenty-first century classroom. ePortfolios can also have many different purposes, depending on the context in which they are used. Barrett (2004) looks at the different purposes of portfolios and classifies these under three headings:

- An assessment tool to document the attainment of standards (a positivist model)
- As digital stories of deep learning (a constructivist model)
- As digital résumé (an employment portfolio)

ePortfolios as repositories of student work which can be presented for assessment are discussed in Stefani, Mason, and Pegler (2007): “Portfolios, in education and personal or professional development are collections of documents and other objects that can be shown as evidence” (p. 9).

In Ireland, the National Council for Curriculum and Assessment (NCCA) emphasise the dynamic nature of an ePortfolio in capturing student progress, as proposed in the context of Level2 Learning Programmes.

> An ePortfolio is an electronic collection of evidence showing learning over time. An ePortfolio provides learners with a dynamic workspace whereby they can capture their learning, their ideas, access their collections of their work, reflect on their learning, share their learning, set goals, seek feedback and showcase their learning and achievements (NCCA, 2014).

ePortfolios also have potential as a pedagogical tool for the development of ongoing assessment in the classroom. This was highlighted in studies carried out by the U.S. Department of Education in the development of their *National Educational Technology Plan* (2010). Their research found that using ePortfolios promotes student self-awareness and supports the development of student autonomy through facilitating ongoing assessment:

> Technology also gives students opportunities for taking ownership of their learning. Student-managed electronic learning portfolios can be part of a persistent learning record and help students develop the self-awareness required to set their own learning goals, express their own views of their strengths, weaknesses, and achievements, and take responsibility for them. Educators can use them to gauge students’ development, and they also can be shared with peers, parents, and others who are part of students’ extended network (p. 12).

The value of an ePortfolio in promoting ongoing assessment is supported by Klenowski (2002), who found that when using such platforms that:

> Student understanding and reflection on the process is valued … the learner has a central role in the process … feedback that students receive from their teachers or peers has a transformative function (p. 56).

In their work in the UK, JISC (2008) also highlighted the manner in which ePortfolio platforms support ongoing assessment, referring to the

> rich and complex processes of planning, synthesising, sharing, discussing, reflecting, giving, receiving and responding to feedback … [where] the process of learning can be as important as the end product (p. 6).

Ouyang and Andrews (2005) cited in Lambert, Depaepe, Lambert, and Anderson (2007) posit that the ePortfolio can also support the development of digital literacy, as

> The beauty of [the use of] an ePortfolio is that it fosters active learning, not only in the areas of the subject contents but also in the use of technology (p. 5).

An EUfolio ePortfolio definition was developed following this literature review through an online collaborative process between all partner countries. This definition was agreed to be the closest to the aims of the pilot project, particularly in terms of collaboration and reflection.

> ePortfolios are student-owned dynamic digital workspaces wherein students can capture their learning and their ideas, access their collections of work, reflect on their learning, share it, set goals, seek feedback and showcase their learning and achievements (EUfolio, 2015, p.8).

The definition of the portfolio strongly advocates using the portfolio to support formative assessment practices (reflect, share, set goals, seek feedback); as a digital storage (capture learning, dynamic workspace, access and showcase collections) and facilitates key skill development (collaborate, communicate, manage information, be creative and manage their thinking). JISC echo this learner-centred philosophy as their research shows that the ePortfolio can

> … demonstrate what is important about individuals at particular points in time – their achievements, reflections on learning and potentially a rich and rounded picture of their abilities, aspirations and ambitions (JISC, 2008, p. 6).

The review of ePortfolio literature also unearthed approaches to the ***process*** of ePortfolios that are essential in planning for ePortfolios. Pachler and Daly (2011) posits that within portfolio-based learning, students "*develop an improved understanding of the self and the curriculum through engagement*, *personalization and reflection*" (2011, p. 123). This increased self-awareness and self-reflection was a key tenet of the EUfolio project.

JISC (2008) elaborate on how portfolio-based learning linked with the experiential model of learning proposed by Kolb supports this approach to learning. This is illustrated in Fig. 9.1 below.

In an investigation of ePortfolios in teaching and learning, Alawdat (2014) conducted a review of models of ePortfolios used over a 10-year period and grouped the findings under the headings of showcase, learning, assessment, reflection and feedback. A summary of these findings is presented in Table 9.2 below.

This developmental research supported the evolution of the EUfolio ePortfolio model. In this, model partners focused initially on the work of Abrami and Barrett (2005) who propose three different types of portfolio: "*process portfolio*", which

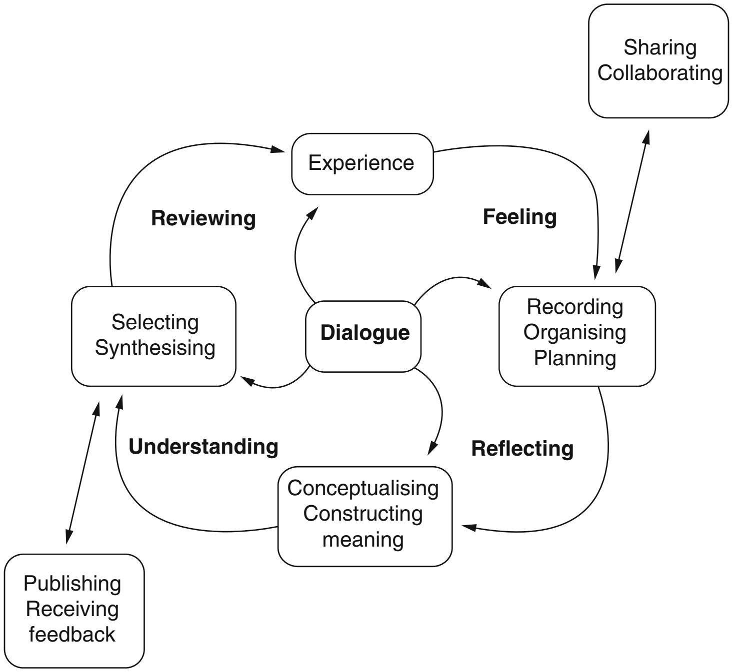

Fig. 9.1 A model of ePortfolio Learning (JISC, 2008, p. 9)

shows the student's learning journey; a "*showcase portfolio*," where students display their best work; and an "*assessment portfolio*" which students can put forward for assessment. This model of portfolio begins to emphasise the importance of process in learning and the need for feedback, with the student's best work emerging from the process displayed in the showcase portfolio, and the option to further prepare a portfolio of work for summative assessment.

The development of the EUfolio model was further advanced through a study of the work of Himpsl-Gutterman (2012) cited in the *EUfolio Implementation Guide for Policymakers and Practitioners* (2015, p.15). Himpsl-Gutterman proposes an ePortfolio structure with repository, journal and showcase aspects (Fig. 9.2).

Within this model, the focus is on the learner and the process of learning. It underlines the importance of feedback for the learner and promotes student reflection throughout the process of learning.

Having focused on the ePortfolio models of both Abrami and Barrett (2005) and Himpsl-Gutterman (2012), the EUfolio project team developed a hybrid three-level ePortfolio model to support teaching and learning in lower secondary education, and reflect the spirit of the project ePortfolio definition. This model integrates the processes of learning and proposes that students engage at all three levels throughout their learning to support the progression of a piece of work from conception to completion, and integrating formative assessment throughout the learning process.

Table 9.2 A brief summary of ePortfolio Characteristics and Definitions (Alawdat, 2014, p.2)

Characteristic/Foci	Research	Definition
Showcase	Abrami and Barrett (2005)	A digital container to visual and auditory content, texts, images, videos.
	Health (2005)	A way to showcase technology skills.
	Butler (2006)	A place to house student's make connection with peers
	Yancey (2009)	Electronic container for students, teachers, and job seekers.
Learning	Abrami and Barrett (2005)	eportfolio is flexible, inclusive, and distributed of learning including variable times and place for learning.
	Jarrot & Gambel (2011)	Simplifies the process of student learning.
	Love & Cooper (2004)	Provides a rich picture of student learning and competences.
	Kirkham et al. (2009)	Provides more in-depth learning and enhances the quality of artefacts.
Reflection	Barrett (2009)	Reflection is the soul and heart of eportfolios
	Desmet et al. (2007)	Encourage students to reflect on their work and their choices of their artefacts.
	Cambridge (2010)	
Assessment	Cambridge (2010)	Promote student understanding of assessment to improve learning
	Chalk & Wire (2013)	Offers powerful ways to develop assessment skills.
	Change, Tseng, & Lou (2012)	Involves assessing the student learning outcome.
	Wade et al. (2005)	Employ students in the assessment process.
Feedback	Abrami and Barrett (2005)	Gives feedback quickly through construction eportfolios across media.
	Lorenzo & Ittleson (2005)	Facilitate exchanging of ideas
	Peacock et al. (2012)	Enables feedback anytime understanding of learning process.
	Wills & Rice (2013)	

The three levels of the EUfolio model (See Fig. 9.3 below) are integrated to support the student at different stages in their learning as outlined in The EUfolio *ePortfolio Guide for Policymakers and Practitioners* (2015).

Level 1: Student Repository

Students can use their ePortfolio space as digital storage, where they upload and collect artefacts. They can also collate exemplars of work to support the development of success criteria for the task or assignment they are working on or to use as stimulus material. These exemplars can be multi modal, including audio, video, images and text.

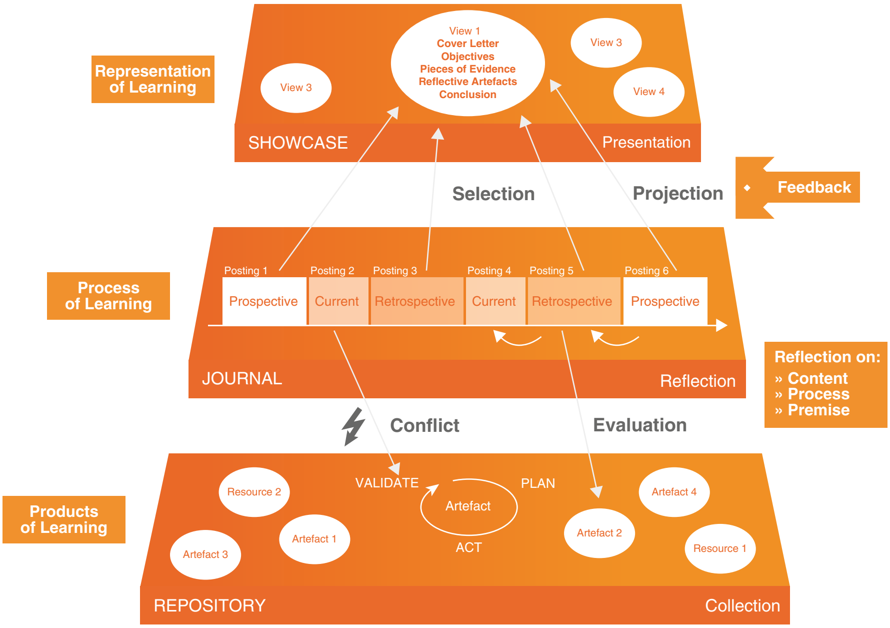

Fig. 9.2 3-layer structure of ePortfolios (Himpsl-Gutermann 2012, p.239)

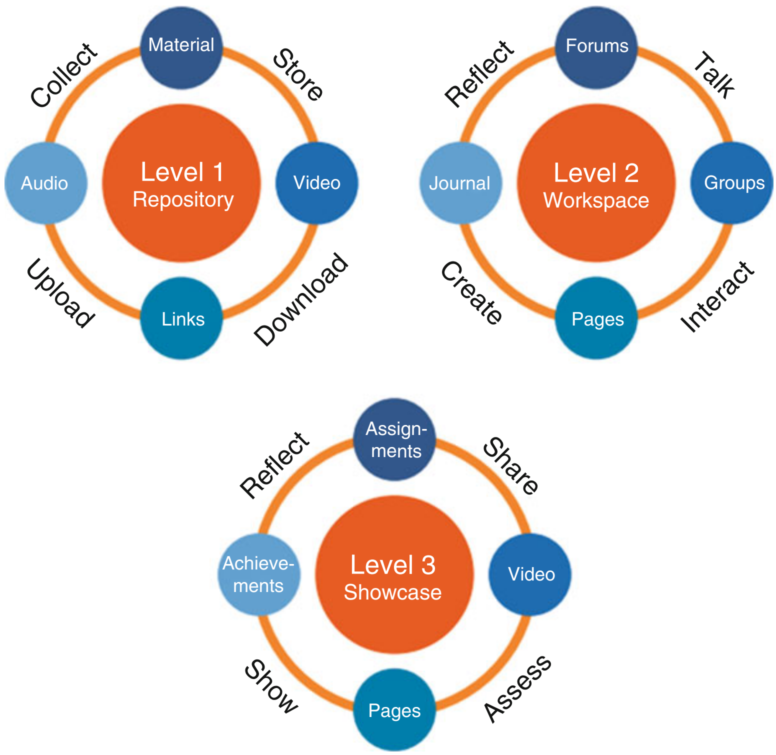

Fig. 9.3 EUfolio 3 Level ePortfolio Model (EUFolio, 2015, p.13)

Level 2: Student Workspace

In the workspace, students can plan, set goals, organise learning experiences chronologically, collaborate with peers, reflect on their own learning process and on the work of their peers. They can create and upload artefacts (storage), discuss with peers the selection of their artefacts, work collaboratively or alone and organise their resources. Thus, a cycle of self and peer reflection as part of the learning process is facilitated. In the workspace, teachers and peers can provide formative feedback.

Level 3: Student Showcase

The showcase element of the ePortfolio can demonstrate a student's competences, achievements and products. A student can edit and select their artefacts to showcase their reflections and achievements as well as contributions and feedback from peers and teachers. The "final" products in the showcase part of an ePortfolio can be evaluated by the teacher as a summative assessment of learning.

The ePortfolio model used in the EUfolio pilot implementation was intended to place a focus on student learning with an emphasis on the process of learning; to promote collaboration and dialogue; to foster peer assessment; to develop critical thinking skills and metacognition, to promote student reflection & self-assessment and to support teachers in providing effective feedback and in tracking student progress.

The Irish Pilot Implementation: Findings

Each piloting country in the project collected data from the schools, teachers and students involved in the pilot implementation. A case study approach, as outlined by Yin (2009, p. 46) was used as the research methodology, taking an embedded approach with multiple units of analysis. Each classroom implementation within the country was considered as an individual case study in the context of the wider country implementation. Data was collected from teachers through questionnaires, interviews and focus groups, while students were interviewed and project mentors also contributed to the research through classroom observations. The results of the pilot implementation were analysed under two headings, referring to the project's evaluation and research questions.[4]

As outlined previously, the Irish pilot implementation took place in tandem with piloting in other countries. The pilot involved two phases, and was supported by

[4] In the code presented here, IE refers to the country (Ireland), S refers to the school, T refers to teacher (within the particular school), P refers to student (within the particular school) and M refers to an Irish mentor on the EUFolio project.

tailored CPD supports and technical support as necessary throughout. Three main benefits of ePortfolios emerged from the data analysed within the Irish pilot implementation, and these are presented below.

Digital Storage Capacity

Teachers highlighted the potential of the ePortfolio to support storage of student work. It was described as a "*safe*, *secure and stimulating environment*" (Teacher IE-S1-T1) and observed that it was "*helpful to have the work in one space*" (Teacher IE-S3-T1). Teacher IE-S3-T1 also referred to what he called "*squishy banana syndrome*" where students have issues minding and storing homework and this is counteracted by the repository function of the ePortfolio. This was supported by the comments of students, such as student IE-S2-P3 felt that the ePortfolio made it "*easier to mind my work*" and student IE-S1-P4 who also said that the ePortfolio "*helped to keep everything together*".

Another advantage highlighted was the potential to store the work in different file formats as the ePortfolio supports digital file formats. "*The multi-media storage was really useful for videos*" (Teacher IE-S4-T2). Students in IE-S2 said that they "*liked the way all their work was in one place*" while students in IE-S3 noted the fact that the ePortfolio could "*store all sorts of files not just typed up things*". Student IE-S3-P2 echoed this "*It was handy to be able to store examples of work in the folders and to use these to see what the report should look like and then it was good to have all the work stored in one place when the teacher was looking for it*". Project mentor IE-S3-M1 observed student organisational skills in action during class observations and noticed the clear use of a "*filing system*" by the students in the class and an ability "*to access stored work quickly*". There was an overall belief that the multimodal capabilities of the ePortfolios supported a range of learning styles as students were not restricted to text-based resources.

These findings, in particular relating to the multimodal aspect of the ePortfolio echo previous research conducted by Dillon and Brown (2006) who found that:

> print technology has become both a filter and framework for storing, representing, communicating and expressing valuable cultural ideas. However there has not been much consideration of 'textualized' experiences or products and in what ways words filter meaning. EPortfolios provide an opportunity to redress this imbalance and to manage media rich expressions and representations of human activity in an integrated fashion (p. 419).

Supporting Formative Assessment

Pilot implementation research findings indicated that the ePortfolio could provide significant support for formative assessment in the classroom. Teacher IE-S2-T2 said that it "*provided a good way for me to give better feedback to the students*". This was supported by IE-S1-T3 who stated that "*the ePortfolio provides an ability* *to give formative feedback which is a valuable teaching and learning tool*". IE-S4-T1 also reported positive formative assessment findings, stating that "*the students paid much more attention to my feedback …. It was an excellent vehicle for providing feedback to the students in a timely and meaningful way*".

IE-S3-T1 also reported an increase in student self-reflection and that "*it was good for the students to be able to see the teacher's comments and respond and ask questions for clarification if they needed*". This was supported by the findings of the questionnaire responded to anonymously by teachers, which found that 72 % of teachers strongly agreed that the ePortfolio supported student reflection, while 11 % agreed with the same statement.

Students IE-S2-P3, IE-S2-P6 both said that they found it "*easier to see how to make their writing better with the portfolio*". Teachers in these schools observed that the ePortfolio offered flexibility in drafting and redrafting student work and as a result this "*made formative feedback more manageable*". Students IE-S2-P1 and IE-S2-P2 in the same school explained that they were "*thinking more about what the teacher told us to do to improve*". Mentors visiting school IE-S3 noted that students were given time at the beginning of class to assimilate feedback on previous work and some used the opportunity to electronically ask questions from the teacher.

Teachers found that having clear success criteria supported them in providing effective formative feedback to their students. Feedback in line with these success criteria coupled with the fact that students could access the ePortfolio platform both at home and in school meant that there was "*a clear overview of student progress*" (Teacher IE-S3-T1) for both "*teachers*, *students and parents*".

The digital potential of the ePortfolio allowed for feedback in formats other than writing. Student IE-S8-P7 spoke about how the ePortfolio platform helped her to get feedback in a language class "*I can record myself speaking and the teacher can listen after class and can give me feedback on what it sounds like and tell me how to improve things like my accent*". She continued "*then I can re-record myself taking what the teacher tells me to improve on and then she can listen again to see if I have it right*".

These findings in relation to formative assessment emphasise the importance of the process of learning and reflect the work of JISC (2008) who argue that:

> Behind any product, or presentation, lie rich and complex processes of planning, synthesising, sharing, discussing, reflecting, giving, receiving and responding to feedback. These processes are the focus of increasing attention, since the process of learning can be as important as the end product (2008, p. 6),

while Dillon and Brown observe that ePortfolios lead to a "*power shift to the student*, *or at least a responsibility shift—a democratisation of the assessment process*" (2006, p. 420).

Developing Twenty-First Century (Key) Skills

The use of the ePortfolio enhanced the development of twenty-first century skills through the integration of the ePortfolio into teaching and learning. Teacher IE-S1-T1 found that "*ePortfolios certainly go a long way in assisting critical* *thinking*, *problem solving*, *independent learning*, *working collaboratively and most importantly ICT*". Teacher IE-S4-T1 highlighted the development of digital skills and while IE-S2-T2 highlighted critical thinking skills "*it was easy to see that the students were using critical thinking skills when they were deciding on how to present the work in the portfolio*". Teacher IE-S1-T2 said that "*the true value came when creativity on behalf of the student and teacher was at an optimum*".

Reflecting the formative assessment findings above in addition to student reflection Teacher IE-S3-T2 stated that "*I also think it developed their reflection skills as they had to think more about what they were doing and the feedback they received*". Teachers IE-S7-T1 and IE-S7-T2 both agreed that the implementation helped the student's skills in managing information and learning. IE-S7-T1 observed that "*Students have organisational issues*, *as they haven*'*t done this before*, *initially had to be done for them*, *but it is a skill that they needed to learn and they have improved*". Teacher IE-S5-T1 noted increased collaboration between students "*Collaboration skills were definitely better. Some stronger students were helping others without being asked to*". Student IE-S6-P5 also reported an increase in communication and collaboration "*if you weren*'*t sure what to do or if you were doing the right thing you could post a question and the teacher or even some other students could answer you*". In terms of communication skills, questionnaire responses showed that 41 % of teachers surveyed strongly agreed that the implementation improved student communication skills, while 30 % agreed.

Recommendations for Policy and Practice

The benefits of using ePortfolios in teaching and learning have been clearly identified in the analysis of this pilot implementation. However, the project data has also highlighted a number of challenges that significantly impact on successful implementation and pose challenges for both policy and practice.

The Irish pilot implementation suggests that successful implementation of ePortfolios is strongly dependent on two main factors: training and infrastructure. Teachers require intensive technical support and the mentor model employed in the pilot implementation in Ireland was successful in providing ongoing support in particular from a pedagogical perspective as it is essential that ePortfolio is integrated into pedagogy and uses a student-centred approach to learning.

This echoes the findings of JISC (2008) who report that the ePistle project

> found that e-portfolios need to be experienced as part of a considered and planned curriculum, and that success is dependent on the fit between the e-portfolio system, the curriculum and learners' needs. They found that once the technical issues were sorted and that the training for practitioners in the use of the software and the appropriate pedagogic approaches took precedence, confidence increased markedly (p. 26).

The OECD (2015) also highlight the importance of teacher training and CPD:

> … it takes educators time and effort to learn how to use technology in education while staying firmly focused on student learning. Online tools can help teachers and school leaders exchange ideas and inspire each other, transforming what used to be an individual's problem into a collaborative process (p. 16).

Having a supportive school management team was also a factor in successful implementations and also resulted in the cascading of expertise in a number of schools, where the EUFolio trained teachers further disseminated the platform within their own schools. The project also found that teachers involved in an ePortfolio implementation would benefit from time to collaborate and plan outside of the classroom.

Before embarking on a school-based implementation it is essential to be realistic in terms of what the school can achieve and to develop a plan for implementation, which should be an individual plan based on the school infrastructure and teacher capacity while ensuring that an integrated approach is taken. Infrastructure, in particular broadband connectivity, can greatly impact on the use of the ePortfolio platform and schools need to consider the access that students have to ICT infrastructure, including whether to explore a Bring Your Own Device option for students.

However, despite these limitations, the findings from the pilot implementation illustrate that ePortfolios offer a wide range of potential in Irish second level education. The multimedia capacity of the platform offers opportunities in all subjects, including those with an oral component. The repository function of the platform enables safe storage of work over a period of time, which is immensely beneficial for assessments and particularly where a student moves school. Where used on a cross-curricular basis, the ePortfolio greatly increases the potential for cross-curricular collaboration and for students to develop transferable skills and offers interesting opportunities to students in planning their careers and in developing as life-long learners and support them in navigating the "*digital landscape*" (OECD, 2015, p. 17).

In terms of the original project vision regarding formative assessment, it is clear that embedding the ePortfolio into teaching and learning supports teachers in linking teaching and learning through "*front-ending*" assessment which Wyatt-Smith and Bridges (2007) explain as giving direction through connecting planning, teaching activities, assessment and gathering evidence. In addition, the integration of ePortfolios into teaching and learning gives a rich overview of the student's learning as it supports the triangulation of evidence of learning (observations, conversations and products), as depicted by Davies (2007).

This approach to planning for assessment (both formative and summative) is greatly supported by the potential of the ePortfolio to enable teacher collaboration in planning both on a disciplinary & cross-curricular basis. This is supported by the findings of McEwan (2009):

> working collaboratively is the only way a diverse faculty with diverse students can hope to achieve the alignment of content standards, curriculum, instruction, and assessment that are needed to raise the achievement bar for all students (p. 96).

In summary, the findings of the EUfolio Irish ePortfolio pilot implementation echo the work of Livingstone (2012) in providing a platform for and supporting "*a more flexible*, *learner-centred notion of education that facilitates the* [*development*] *of soft* [*key*] *skills*" (p. 10). This approach to education perfectly complements the paradigm shift in Junior Cycle reform and underlines the pedagogical benefits of embedding ePortfolios in teaching, assessment and learning.

The official EUfolio project website with details of all project partners and pilot implementations can be accessed at www.eufolio.eu, with a resources portal available at http://eufolio-resources.eu/. The Irish partners in EUfolio were Department of Education and Skills (lead partner) including Junior Cycle for Teachers Support Service; H2 Learning; NCCA, Microsoft Ireland, Dublin West Education Centre and the State Examinations Commission.

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Chapter 10
Taking the Tablets: Has the Long Predicted Revolution in Teaching and Learning Finally Arrived?

Christina Preston and Sarah Younie

Abstract Keeping up to date in education innovation is not an easy option for the classroom practitioner. In particular, digital technologies present a challenge because they are expensive to implement; teachers require technical training; and, professional development programmes that concentrate on pedagogy and impact are not always available. This chapter explores the ways in which the MirandaNet Fellowship 'community of practice' tackled the implementation of personal tablets in schools through reading members' studies, international online discussion and practice based professional development projects in the classroom that aimed to build policy and strategies on the basis of teachers' and pupils' evidence.

Keywords Mobile devices • Tablets • Teaching and learning • Professionals • Community of practice • MirandaNet • Innovation • School environments • Systemic change • Social networking • Online practitioner debates • Conferences • Action research • Professional community • Curriculum theme • Leadership • Technologies • Community group • Face to face

Engaging the Professional Community

Ever since the MirandaNet Fellowship[1] of educators was founded in 1992, this professional e-community has been expecting a revolution in teaching and learning because of the impact of digital technologies in schools. Over the years we have

[1] The Mirandanet Fellowship is a community of practice that is free to join: mirandanet.ac.uk. Most of the contents of the Knowledge Hub is accessible by non-members except some draft papers and the mirandalink archive.

General members' publications are here: http://mirandanet.ac.uk/knowledgehub/publications/publications/

Reviews of books by MirandaNet members are here: http://mirandanet.ac.uk/knowledgehub/book-reviews/

Consultation submissions are here: http://mirandanet.ac.uk/knowledgehub/white-papers/

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grown from 15 teachers in England who saw themselves as thought leaders in education innovation to more than 1000 members in 80 countries. Our online and face-to-face debates and our members' publications on our website bear witness to exponential increase in the use of technology in business and leisure as a global phenomenon.

Our hopes for a revolution in the field of education strengthened in 1997 when the UK government introduced the National Learning Grid: the first internet service for education in the world. However, we are a professional organisation who are enthusiasts for change. Generally speaking, unlike the workplace that has been transformed by technology, most classrooms have continued to look much the same for the last 100 years. Most pointedly Younie and Leask (2013) comment on how the integration of technology has not been fully realised in education because of the lack of knowledge by decision makers—both policy makers and school leaders—about the opportunities opened up for new pedagogical approaches with technology.

So has a tipping point been reached in education innovation as described by the change management guru, Fullan? In his comments in his blog, he represents the powerful combination of experience, knowledge, practice and strong feeling that is at the core of professional educators' daily experience. In order to engage the community in his ideas he blogs about his passion as well as giving the matter in hand scholarly consideration.

> There is a grand convergence spontaneously erupting. I think it is the natural dynamic of push and pull. The push, to put it directly, is a combination of the boredom and alienation of students and teachers. Students won't wait, teachers can't wait.[2]

These ideas about convergence in how to change systems that Fullan expresses passionately in his blog he describes in a more scholarly style in *Stratosphere* (2012) where he explains that the three forces of technology, pedagogy and knowledge have the power to transform education.

We argue that in both kinds of communication, social media and scholarly writing are equally important for professional learning. Most professionals will recognise in Fullan's blog utterance the powerful combination of experience, knowledge, practice and gut feeling that is at the core of professional educators' daily experience.

In the MirandaNet 'community of practice' (Lave & Wenger, 1991) there are policy makers, scholars and practitioners who all contribute to debates, conferences and publications about topics related to innovation from their different perspectives. Many of them are academics but they are also adept at communicating immediate and significant ideas in social media often before they have gone through the academic process. In fact many of these ideas are not subject to academic proof at all but experience and knowledge make them valuable to professional as long as they know the context and can make their own judgements. In this way a community of practice like the MirandaNet Fellowship helps the sharing of knowledge and experience between the policy makers, theorists and the practitioners so that synthesis emerges between the groups and new insights are won. This approach also helps to

[2] Michael Fullan: Motion Leadership http://www.michaelfullan.ca/.

strengthen the links between technology, pedagogy and knowledge in members' schools.

Lave and Wenger (1991) argue that learning from each other began with the medieval guilds and has always been a successful way of sharing experience mainly face to face. The MirandaNet Fellowship is free to join for those educators who are keen to learn from one another. Indeed the reach has been extended because members can engage in online communication with like-minded professionals anywhere in the world with internet access. Traditional social interaction is now strengthened further by creating contexts for informal dynamic knowledge creation in collaborative contexts as the participants move from textual debate in a conventional listserv to video conferencing, microblogging contributions, collaborative digital concept maps and group responses to government consultations (Haythornthwaite, 2007; Preston, 2008).

In this chapter we use the topic of mobile devices or tablets in teaching and learning to show how professionals in a community of practice like MirandaNet can learn and share ideas about innovation in schools by choosing the modes of learning that suit them and their situation at any time in their professional career. Members rarely leave MirandaNet because they can keep abreast of current knowledge that still suits when they change their role and fits into the time they can commit to learning.

So, as an example of how a community of practice can work today, we show how a member might learn about the role of tablets in systemic change with respect to social networking, online practitioner debates, through online members' publications, conferences and through action research projects. These are principles that any potential professional community could adapt to any curriculum topic or leadership topic now that technologies exist to sustain a group that cannot easily meet regularly face to face.

Practitioner Debates

MirandaNet members can use the forums for detailed discussion, but all the members subscribe to a general email list called mirandalink where different threads are introduced by members on topics that seem to be current.

In a mirandalink debate called *Tablets good*: *smartphones bad*! members explored the issues surrounding the introduction of tablets in schools. What gave rise to the debate was that fact that the UK government and the inspectorate had announced a review[3] of the use of tablets and smartphones because of the suspicion that they were a key cause of disruption and indiscipline in the classroom. The new UK government behaviour expert Tom Bennett[4] had been asked to look into this possibility in more depth.

[3] Impact of smartphones on behaviour in lessons to be reviewed https://www.gov.uk/government/news/impact-of-smartphones-on-behaviour-in-lessons-to-be-reviewed.

[4] http://www.theguardian.com/education/2015/jun/20/tom-bennett-school-behaviour-tsar-class-discipline.

In this context, practitioner Drew Buddie, an Information and Communications teacher and MirandaNet Fellow, explained that he had been interviewed about this topic for a Times Education Supplement journal article[5,6]. He maintained that significant differences exist between the affordances of smartphones and tablets. Whereas he is broadly in favour of the educational value of tablets when they are well managed, he also said in the mirandalink debate, 'Mobile phones should absolutely not be allowed in the classroom because there is far too much opportunity for distraction'. His professional view is based on his classroom experience in England where many pupils have many access routes to the internet.

Other international members pointed out that banning phones in their countries in schools could be detrimental to learning as they are often used as tablets when tablets themselves cannot be afforded: Pakistan and Gambia were represented here. Although half of the world's population has access to mobile phones, many will have no other access to digital technologies. Others pointed out that many of the disadvantaged even in rich nations only have smartphones. Another key point that was made by discussants was that smartphones could work for learning as well as any other device where teachers had adequate control over their classes and the school culture supported independent learning.

Other members explained how it was the personal ownership of tablets that was making a key change in attitudes just as Fullan implied. Over the last 20 years keeping the school networks and computer rooms functioning had absorbed staff energy, consumed money and put control in the hands of the network manager. In contrast, MirandaNet Fellows were now observing in many contexts how a step change in practice because personal tablets and smartphones put powerful and affordable tools in teachers' personal control, 24/7. Various members agreed that this technology was smoother, faster and more intuitive, and its uses in everyday life had stimulated a much wider professional understanding about how this technology might be used in the classroom and at home. The technology had been demystified—usage was now the norm—great strides had been made in technical reliability and software is more intuitively designed.

In these circumstances some discussants concluded that the personal ownership of any mobile device, defined as tablets, smartphones, iPods and others, helped teachers to develop an intuitive and internal understanding of how these powerful tools might translate into the learning context. The majority view was that well-equipped teachers cannot fail to improve learning using their first-hand knowledge of these devices.[7]

However, some pointed out that evidence from research indicates that the change is not in the technology itself but in a much wider professional understanding about how technology might be used. One member drew attention to a specific publication

[5] https://www.tes.com/news/school-news/breaking-news/ofsted-warns-against-extremely-disruptive-tablets-school.

[6] https://cogitateit.wordpress.com/2015/12/16/disruptive-technology-part-2/.

[7] Mirandalink debates can be accessed by members: http://mirandanet.ac.uk/join/joining-the-fellowship/.

by Pickering (2007) that introduces new learning strategies emerging from use of mobile devices focusing on three key themes: shared practice, collaborative continuing professional development and scholarly reflection. Valuable research from Australia about the use of smartphones in schools was also cited (Hartnell, & Rose, 2008; Hartnell-Young, Heym, & Rose, 2008). This report emphasises strategies to avoid students being distracted from learning by their phones. The main point was that although the teachers in our research using the smartphones were valuable, they agreed that there should not be any blanket banning policy. Instead teachers and schools should work towards dealing with the planning and management issues to enable the use of these resources for the purposes of learning.

This mirandalink debate demonstrates that professionals can gain valuable and current knowledge from the social media generally and from closed debating systems like MirandaNet even if they do not have time available for more detailed studies. Some MirandaNet members, however, choose to submit an article to the MirandaNet journal for peer review because they learn from this form of writing: incidentally when published they gain a Fellowship. Others publicise their books through the MirandaNet network.

Practitioner Publications

The only selection criterion for articles about education innovation for the MirandaNet Journal is that the piece must be interesting to other members. There are no strict academic criteria in order to encourage practitioners to share. The peer reviewers also offer help to those who are not practised in writing or whose first language is not English. Members submit a variety of expert opinion pieces or case studies offering new insights into education innovation. Masters and Doctorate students often publish articles about their research in progress and as a result often make contact with others members interested in the same field. Historians of Computers in Education can also trace themes across more than 30 years of submissions.

The following is a case study about tablets submitted by a MirandaNet Fellow, David Fuller (2014), based on his work as a teacher trainer that records the learning processes experienced by the teachers in a tablets workshop[8]. The value of ownership of mobile devices was immediately obvious in the teachers' positive attitudes and high levels of competence. The workshop was in preparation for the new school year when all the staff and pupils of this small primary school would be given personal tablets. Although they already had some personal tablets in school, each teacher was already using a device and/or smartphone for their personal and professional use. In most cases they could not now envisage their lives without this device so adopting tablets in school seemed logical to them; there was no reluctance. Such personal familiarity with the technology would not have been the case 5 years ago.

[8] MirandaNet associates, Tablet Academy, run course for schools about using tablets creatively in schools. http://www.tablet-academy.com/.

For the head teacher a professional development day was an effective way of engaging all the staff in the planning and the vision as well as technical competence. Each teacher was supplied with a selection of android tablets although most of what was discovered about the Cloud would also apply to Apple devices. The android devices could be used with a mouse, a keyboard, or as a touch screen with finger or stylus, depending on what was most appropriate. Handwriting on the screen was instantly and accurately recognised and turned into computer text. These tablets were loaded with a new integrated package called Microsoft Office 365 that provides a good example of how versatile tablets can be when they are linked through the Cloud. This particular package includes Yammer (protected social networking including microblogging), OneNote (Digital notebooks), OneDrive (unlimited Cloud storage) and Lync which is now Skype for business and education and other more familiar Office applications including Word, Excel and Powerpoint. Office 365 online comes as free to schools, if they already have a licence for Office. Feedback is facilitated because there is a space for the teachers to comment on the work of individual pupils and communicate with them. In addition, there is a collaborative area where discussion and problem solving can take place. The wifi connection made seamless interaction between all the packages reliable anywhere, anytime and the package can be used on any platform. A search function covered them all. Incidentally the data are held on servers in Europe, which is important in the regulation of data management in UK schools.

This integrated package was new to the teachers who shared ideas about how to use them creatively to advance learning knowing that the students would be safe. As they worked the teachers suggested: targeted content libraries created by the teachers; different digital exercise books for each subject that can be marked digitally; creating books; quicker feedback to students; setting up powerful searching using tags; tagging videos; tagging to a pin board; split screen working; mixed media learning resources especially for presentations; immediate translation; making notes without affecting the original document; Skyping with experts across the world; and emailing homework to parents. One teacher surmised that this might would be the end of parent evenings—teachers could simply Skype with parents by appointment. There was even a hands-free function for the camera so that sticky fingers did not smear the screen. However, the teachers also agreed that even if paper might be the best option for the task in hand at least they now have the choice.

But when a school first takes delivery of tablets, teachers need support in relating what they can do to classroom practice even if they have had an initial workshop. Fuller, therefore, extended his case study to include how he had seen tablets used in a school after the same basic workshop training. David worked closely with the chain of schools to translate the potential of a tablet into classroom practice. To do this he also harnessed the students' empathy with this technology—a valuable source of insight for teachers. David advocates allowing students to experiment, share and, most importantly, to reflect on the potential the technology offers the students. For example he describes students writing their own books saying that the way in which the tablets facilitate the sharing of data seamlessly and with ease provided students with an instant opportunity to peer review other student's work.

> For the final section of the lesson, they passed on their book to a colleague who completed audio or video feedback on what they thought about their book for the author. This proved really useful encouragement for the SEN children who attended the session. Although this was important for SEN students, in reality this was one of the positive aspects in using tablets for students of all ages. The key point being using the Cloud makes sharing easier than with using the established techniques for PCs and laptops.

The data from students and staff (Years 5–8) from 180 schools that Fuller collected with the teacher in training sessions pinpointed the features that schools who were about to buy tablets should consider: how long they last on battery power; their ease of use and touch displays where keyboards were also not required because they are easier for the students to use including exploring different types of apps/software quickly and with no barriers to their understanding.

We suggest that this kind of full staff involvement in the introduction of tablets including data collection helps to ensure that the investment will be worthwhile. Sadly there is plenty of evidence where schools, regions and even whole countries have bought tablets before agreeing how the teachers will be engaged and what the devices will be used for.

MirandaNet Fellows also review members' books. Three books published by MirandaNet practitioners include several case studies about tablets in innovation because knowledge and experience is now being built up in schools about how to plan and implement such projects.

In *The ultimate guide to ICT across the curriculum*, Jon Audain (2014) foresees the ways in which the deployment of mobile devices will impact on the design of learning spaces. He argues that pupils with these devices at home will be bringing expertise to the classroom that teachers will need to take into account. He lists the new elements in pedagogical strategies that teachers need to be acquainted with where tablets are concerned: 1:1 computing; Bring Your Own Device (BYOD) and Bring Your Own Technology (BYOT); Cloud Computing; and Flipped Learning.

In their book *Learning with Mobile and Handheld Technologies*, MirandaNet member John Galloway with colleagues Merlin John and Maureen McTaggart (2015) aims to provide insight into the reality of mobile learning in situ and they quote the most reliable UK research evidence and new studies that are under way. In addition the background to the projects in the case studies is supplied within a timeline that captures the ways in which ownership of devices has grown and changed and some valuable insights into the costs and the commercial interests. An interesting prediction is that:

> developing countries may soon forge ahead, as free from much of our past techno-baggage, they may be able to take a fresher approach to the potential of devices to promote deeper learning.

MirandaNet Fellow Mal Lee and his colleague, Martin Levins, are most confident about the role of tablets in a revolution in teaching and learning (2012). They see BYOD and BYOT programmes as a tsunami coming across the horizon and subsuming entire school communities in Australia, the US and UK. The question for them is not if, but when. In their book, they aim to explain the implications of these developments in the use of tablets as they see them. Senior leaders in schools will find valuable practical advice about setting up and sustaining tablet projects as well as the justifications for doing so. However, are they right to suggest that the forces impelling the introduction of such technologies and the potential educational, social development, economic, technological and political opportunities opened up by these developments will soon fundamentally change the nature of schooling, technologies of teaching and learning, home-school relations and the resourcing of schools.

Shared practitioner studies are an important means of understanding the range of contexts and cultures in which tablets can be deployed. Yet in the UK the prognosis about the landscape of continuing professional development (CPD) is not encouraging. Fragmentation is increasing not diminishing since the last government study was written (Pachler, Preston, Cuthell, Allen, & Torres, 2011). Since the political party changed in 2010 and austerity took hold, research into CPD nationally has been severely cut. More CPD is being undertaken by the schools themselves who have limited access to outside support for CPD at master's level when established theory is also applied to the topic in hand.

Three Tablet Case Studies

In 2012 MirandaNet Fellows were invited to apply to join a study of tablets at master's level that would help them to assess the progress of their project and decide on the next steps over a year period. This means that Fellows are combining theory with practice unlike the studies discussed before. In this case, three MirandaNet Fellows who were bringing tablets into their schools volunteered to be co-researchers and share the data from programmes that they were managing. By collecting data and analysing the results they expected to improve and refine the methods they had employed to make the investment worthwhile. These three co-researchers took this on because they felt, like Pickering (2007), that educating teachers in the use of tablets was only the first stage if their schools were serious about managing change and embedding good practice.

The CPD Process

This study of tablets drew on the basic principles of the MirandaNet iCatalyst CPD programme based on action research methodology[9] that can be used to assess the value of any innovation in learning. The programme, undertaken individually or as a group activity at certificate, diploma or master's level,[10] draws on Schön's definition of 'action research' as a process for stimulating change that is owned by the teachers

[9] MirandaNet action research notes can be found here: http://www.mirandanet.org.uk/researchexchange/events-2/research-themes/action-research-the-main-principles/.

[10] Details about the iCatalyst action research programme can be found here: http://mirandanet.ac.uk/icatalyst/professional-development-approach/.

themselves. Schön revolutionised traditional ideas about professional learning when he published: *The reflective practitioner—how professionals think in action* (1983):

> I begin with the assumption that competent practitioners usually know more than they can say. They exhibit a kind of knowing in practice, most of which is tacit…Indeed practitioners themselves often reveal a capacity for reflection on their intuitive knowing in the midst of action and sometimes use this capacity to cope with the unique, uncertain, and conflicted situations of practice (pp. 8–9).

This quotation emphasises the complexity of learning how to practice and the value of tacit knowledge, understanding, conflict and lack of certainty that go beyond what can be expressed in conventional academic prose. These ideas were developed in England by educational researchers like Elliott (1991) and Hargreaves (2000) who saw the potential for educational change. Pickering (2007) indicate that these new learning strategies are being refined by the development of new designs for professional learning that focus on three key themes: shared practice, collaborative continuing professional development (CPD) and scholarly reflection.

In terms of tablets one of the most comprehensive scholarly books dealing with the theory as well as the practice of mobile learning in formal and informal education is *Mobile Learning*: *Structures*, *Agency*, *Practices* (Pachler, Bachmair, Cook, Kress, 2010). The City suburb Mobile Learning Group[11] to which these authors belong realised very early on what kinds of changes would occur once learners had access to their own devices in daily life and the potential of these devices as a means of education. While the editor, Gunther Kress, ensures an emphasis on multimodality, the authors chart the rapid emergence of new forms of mass communication and their potential for gathering, shaping, and analysing information, studying their transformative capability and learning potential in the contexts of school and sociocultural change. The focus is on a range of equipment: mobile/cell phones, PDAs, and to a lesser extent gaming devices and music players. But the balance is well judged. The authors explore the integration of the technology into education, without objectifying the devices or technology itself. This approach is reinforced by the discussion of theoretical and conceptual models, an analytical framework for understanding the issues, recommendations for specialised resources, and practical examples of mobile learning in formal as well as informal educational settings, particularly with disadvantaged students.

In fact, Pachler et al. (2010) see a focus on devices as only the first stage of mobile learning. The second is concentration on learning outside the classroom. The third stage is on the mobility of the learner in mixed reality learning, context-sensitive learning and ambient learning. Their aim is to provide compelling arguments, theoretically and practically, for the inclusion of cell/mobile phones in the curriculum. Educators need to keep all these elements in mind when new technologies are introduced. Yet the prognosis about the landscape of continuing professional development (CPD) in the UK is not encouraging as fragmentation is increasing not diminishing since the last study was written (Pachler et al., 2011).

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[11] City suburb Mobile Learning Group http://www.city suburbmobilelearning.net/.

Case Study Methodology

One way that teachers can judge the progress of their tablets project is to analyse the results from the perspective of the three categories of mobile learning offered by Pachler et al. (2010). The first is a focus on devices as only the first stage of mobile learning. The second is concentration on learning outside the classroom. The third stage is on the mobility of the learner in mixed reality learning, context-sensitive learning and ambient learning.

In the three tablets case studies study described in this section Fellows again designed the data collection tools around Guskey's belief that the quality of professional development is influenced by a variety of factors: content characteristics, process variables, and context characteristics.

Content Characteristics Variables include the new knowledge, skills, and understanding that are the foundation of any professional development experience or activity.

Process Variables include the types and forms of professional development activities and the way those activities are planned, organised, carried out, and followed up.

Context Characteristics Variables include the organisation system, or culture in which professional development takes place and where the new understandings will be implemented.

Results can be analysed from the perspective of Guskey's (2002) well-respected multilevel framework to evaluate teacher professional development. He laid out five critical levels for the evaluation of professional development programmes in general: (1) participants' reactions, (2) participants' learning, (3) organisational support and change, (4) participants' use of new knowledge and skills and (5) students' learning outcomes.

This approach to analysing the impact of tablets had been built up in several studies about the role of digital technologies in the change process that MirandaNet Fellows have published. Their focus on professional development in digital technologies began with the government-funded programme in England and Wales intended to engage teachers in innovation and pedagogy that lasted from 1998 to 2003 (Preston, 2004). This report was based on the evidence from two large commercial companies who were training providers. In 2009 Davis, Preston, and Sahin (2009a, 2009b) re-examined the statistics from the perspective of the small local trainers. The local trainers who knew the participants well had had more success in effecting systemic change using Guskey's levels than the large training companies.

In 2012 MirandaNet Research Fellows used the three stages of mobile learning and the five Guskey levels to evaluate the impact of tablets in three secondary schools: in a deprived seaside town; in a rich City suburb; and in an advantaged market town. In each school a MirandaNet Fellow had led a project introducing tablets into their school and was keen to evaluate how this had progressed and how they should move on. They were also interested in seeing how much the different contexts they worked in affected their success. Each Fellow already had a Masters in Information and Communications Technology (ICT) that contributed to their sophisticated understanding of theory and practice.

The data collection tools that were developed for the *Taking the Tablets* project invited the participants to reflect on where they had been, where they were and where they were going based on the three stages of mobile learning and Guskey's levels.

The three action researchers set up interviews to record the full implementation programme and the vision from the perspective of the senior managers, the ICT coordinator, key staff, the action researcher and the pupils in order to write a report on the project for internal use that identified the key issues from the Guskey perspective. Focus groups were also set up to elicit the student response.

Study One: A Deprived Coastal Town

This mixed secondary state school with 700 pupils was in an area of deprivation in a coastal town. The new state-of-the-art building was completed in 2009 after a 2005 fire. During the 4 years much of the communication and learning had been undertaken online and as a result a specialism in technology could be well resourced. The 2012 school inspection reflected good conduct, but judges the school 'requires improvement' because of the achievement, leadership and management concerns. Literacy was another key area for improvement.

The overall ICT infrastructure and resources were of a high standard and the vision was to use technology in innovative and exciting ways despite financial constraints. The student to computer ratio was 3:1 and there were three network staff support for five PC suites. Interactive whiteboards and computers were in each room and some subject departments had sets of devices as well. The intranet was widely used inside and outside school for administration and personal planning. However, there were wifi access problems in the new building because of the concrete walls. Every room was wifi enabled, but the costs of a complete service were impeding full installation for another year.

Overview of the Activity

The senior management team had been working towards independent learning over 5 years with early work focusing on effective use of the Virtual Learning Environment (VLE) from outside school by staff and pupils: student planners and mail to parents are existing services. Bring your own Device (BYOD) and Bring your Own Technology (BYOT) seemed to be the obvious next step. Pupils usually brought smartphones or tablets into school that were mainly Android because this was the parental choice. Currently some were using their parents' hotspots in school until full school wifi was secured. What was significant was that the number of staff with devices was growing. Humanities, Maths, Music, Design and Technology now had sets of wifi-enabled devices that could be used to supplement BYOD/BYOT for those who do not have their own device.

The vision to develop independent learning over 5 years was led by a senior manager. His doctorate in technology and learning was based on researching school practice in this school and others and he kept updated through membership of informal online teaching communities and online courses. His academic leanings and sensitive approach to change were important in ensuring that the project will eventually impact on teaching and learning and will be embedded effectively in staff administration and contact with parents as well. The requirement for autonomy in learning became urgent after the original school was burnt down. For many months the students had to learn from home by accessing the Virtual Learning Environment that has been used in a sophisticated way forced by need. It become clear in the last 2 years that a BYOT/BYOD policy might be a key driver in further embedding independent learning in the school.

Although devices are now being widely used, mainly smartphones, they are still officially banned in the school policies . Some teachers still discourage their use because of their own lack of training and uncertainty about the benefits. In contrast, pupils' journals show that for some the device is a constant source of information and interaction although teachers are not always aware how pervasive they are, or why. Pupils who use them in class admit that they are not always on task—reading emails and accessing Facebook are cited in this context. Pupils in this deprived catchment area also have concerns that their peers are very conscious of the comparative costs of devices and describe the discomfort not only of those pupils who have no device but those who have a less expensive, 'less cool' device.

A key report on smartphones, *How mobile phones help learning in secondary schools* (Hartnell-Young & Heym, 2008) that was followed up by two articles on the topic (Hartnell-Young, 2008; Hartnell-Young et al., 2008), still offers some valuable recommendations which are the need to shift the focus of policy away from the devices themselves to consider the frequently reported reasons that mobile phones are banned: fear of distraction in class, cheating, inappropriate recording of students and teachers, and publication on sites like YouTube. The researchers indicate that solutions must be found to each of these, in policies that address:

- ownership of computing equipment and access to network connections,
- tools to support curriculum and its personalisation,
- appropriate behaviour in school and other contexts,
- privacy and security of data, including photographs and video clips.

Some suggestions are made about strategies that might help schools that do not want to indulge in an overall ban but pursue a more nuanced approach:

- Identify and support champions: volunteer teachers who are prepared to take some risks,
- Involve those who have responsibility for curriculum, student management, and technical support to plan and work through responses to the issues raised in this report,

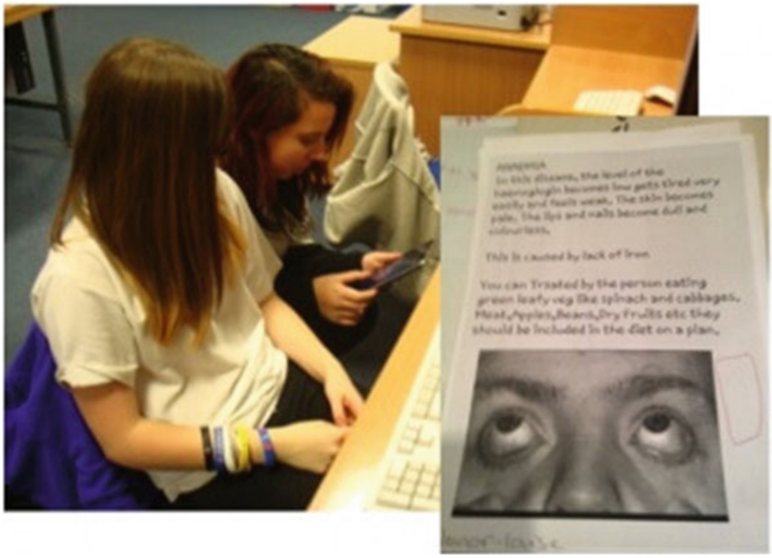
- Initiate discussions about using mobile phones for learning (perhaps using student voice work) and survey current ownership, device capability and the ways mobile phones are already being used in the school,
- Provide hands-on, small-scale opportunities for teachers to try out appropriate uses for mobile phones.
- Encourage teachers to design activities that make the learning purpose clear and to anticipate management issues at the classroom level (such as rules, etiquette),
- Inform parents of the learning purposes for mobile phones, and involve them in establishing appropriate ownership, management and ethical arrangements,
- Anticipate and address technical issues ranging from battery charging to network access and security, data protection, etc.,
- Develop new school policies that shift the focus of policy attention away from the device to the uses, security and behavioural issues that are the real concern.

These strategies could be valuable for the introduction of any kind of learning and teaching technology.

At school one, the BYOT/BYOD research pilot that ran alongside expanded use of the devices in the school was carefully planned to provide evidence to drive the new teaching and learning framework being prepared.

Registration and other administration tasks made easier

A growing number of staff with tablets have also been using them to experiment with administrative task like taking registers, planning lessons on the bus and improving their immediate access to statistics on specific pupils. Pilots have been conducted in departments who expressed a specific need for a BYOT/BYOD intervention in the expectation that some of these experiments will attract the interest of staff who have not yet committed to the use of devices in their classrooms. One classroom activity was research on the internet in science to make a poster about anaemia.



Pupils researching on the internet to make a poster
about anaemia in a science lesson

Analysis and Discussion

The three schools focused the discussions about the findings on the lessons they had learnt and wanted to pass onto others. The organiser in school one felt that working slowly and inclusively in pilot mode had insured high expectation of success in full implementation over the next year. Some key points arose in discussion for inclusion in the emerging policies. The first was that research into ownership was seen as essential in planning the pilot and also in engaging staff, pupils and parents. Ownership of devices at 38 % was lower than expected and has slowed up progress. Provision had to be developed for students and staff who cannot fund their own device.

It was agreed that wifi was essential throughout the school if take-up of BYOD/BYOT is to be improved. An affordable solution had now been found but the absence of overall wifi in the pilot was a barrier to change. It was agreed that the SLT needs to trial more thoroughly key online administrative and teaching software as poor performance dampened enthusiasm for the pilot amongst staff and pupils. It was also matter of concern that currently some staff still ban the use of devices in their classrooms despite changing policy.

According to the pupils more staff need their own devices and specific training in order to ensure a new teaching and learning policy is embedded. Pupils have offered to teach the teachers informally. Pupils using their own hotspots where wifi is not available raised concerns about how the school will control what websites pupils are accessing.

Conclusions on Impact

This well-planned pilot resulted in the outcomes that had been hoped for.

Firstly **in terms of organisation and policy** the school is now in the process of finalising an updated policy for the use of mobile devices in school. Based on teachers' and pupils' observations in the pilot a teaching and learning framework that supports the use of devices is emerging, but currently this is quite limited. Staff plan to widen involvement and share insights in order to ensure the richness of this document. The timescale envisaged is about another year.

Secondly progress has been made in ensuring that **all members of the school community** were aware of the benefits and issues relating to BYOT/BYOD, although it is the enthusiasts at this point who are making progress in developing a code of conduct to be discussed with the community as the next stage. The teachers though that their own achievements had been derived from comparing their responses in the staff base-line survey at the start of the project to the current situation. Staff thought that in the next stage pupils and parents should be included in this base-line survey process.

The third aim, to provide hard evidence of the **impacts of BYOT/BYOD on teaching and learning**, is not well advanced yet although the details of this study provide a vehicle for further discussion and research. The pupils and the teachers can provide convincing anecdotal evidence that changes in performance, engagement, motivation and behaviours have taken place. More systematic action research now needs to take place to confirm that BYOT/BYOD can impact on learning outcomes as well. This will provide detail for the teaching and learning framework that is being developed for staff. Pilot staff are already enthusiastic about the major impact on their lesson preparation time because they can use the tablets in transit: administrative tasks like registration are easier; ease of use in classrooms because of significant time-savings over the use of PCs.

Study Two: A Leafy City Suburb

This selective fee-paying mixed city suburb school with 1200 pupils from 4 to 18 accepts SEN children and offers scholarships. In a wooded setting the historic school offers a broad curriculum in Sport, Music, Drama and Visual Arts as well as extra-curricular activities enabling both breadth and depth of opportunity. The ratio of staff to pcs is 1:1 and for students to pcs 1:2 with good technical support; eight computer suites and computers and IWBs in each classroom; Apple TV and large screens in main halls and meeting rooms (Figure Two). The intranet is widely used by staff and students. Wifi now available to staff and sixth form will soon be available to all. A new Digital Learning Centre is planned to be the cornerstone of a knowledge community by 2013/2014 and the technology is all Apple. Currently 6th Form facilities upgraded to include collaboration desks/shareable screens and charging stations in a collaboration area. Thirty-two staff applied for a discount on iPads and workshops. Hundred and twenty-three staff have laptops from school and, in effect, enjoy 1:1 computing if they wish.

Overview of the Activity

The Senior Leadership team (SLT) decided to implement BYOD/BYOT cautiously in the sixth form, with low impact and attendant risk as part of the move to the new Digital Learning Centre in 2013/2014—a hybrid educator-librarian for transmedia development is now required to work with the architect. Meanwhile a strategic BYOD/BYOT planning process with SLT was based on a survey of devices owned by parents and pupils and other research. Voluntary involvement for pupils and teachers was agreed in the first stage especially as the market for devices is in flux. The Network Support team investigated wireless access and security options in other settings.

Collaborative working desks with iPad connections and Apple tv in the 6th form centre, meeting rooms and assembly halls

The pilot was intended to find a way of introducing more independent learning in preparation for greater freedom in tertiary education. The SLT also wanted to explore other potential teaching and learning opportunities, constraints and challenges. An ICT strategist with a Masters in Business Administration specialising in the systemic integration of social and technical processes in organisations is employed to run the wider project with the director of teaching and learning.

In the pilot of BYOD/BYOT 32 staff have trialled sets of discounted iPads in the attached primary school, in Modern Foreign Languages, Music, Computer Science and Geography. Observation and informal workshop sessions suggest staff see advantages in administration, personal organisation and lesson preparation, but learning and teaching advantages are not as apparent yet. Pupils report in journals easier internet research, better opportunities for collaboration on projects and excellent facilities for viewing each others' work in progress. Knowledge is growing because the pupils and the teachers have been sharing ideas for software relevant to learning, particularly Apps for education.

Analysis and Discussion

The project was deliberately started slowly in the Sixth form because the risks to be avoided from the organisational point of view were seen to be that: a sudden influx of new devices might be too challenging for teachers; too sudden introduction of devices might place strain on networks. In addition theft and loss of devices might occur and appropriate user codes be abused lower down in the school.

The financial advantage can be gauged from a Computer Science example. The department can now afford for each student to work on their choice of computer language using a free or very low cost app. In contrast, a licence for each language for the school network would be about £1500 so only one could be offered.

A key lesson from the pilot was that all teachers must be acquainted with the Code of Conduct that pupils must sign if working online. The Fellows also found that while pupils were comfortable using personal devices in the other aspects of their lives, they appeared to struggle a little with integrating this into school/learning. On the other hand the very flexible environments were important in making it easy and workable to have and manage their own devices in and between classrooms. It also became clear that increased public communication with pupils and parents in the second stage ensured their enthusiasm.

In addition, most of the recommendations related to the encouragement and training of the teachers so that they could support pupils effectively in using technology under their guidance. The pupil focus group agreed that some teachers in the pilot were not aware that time-wasting activities were happening. More teachers need appropriate strategies to deal with these behaviours including getting control early and moving around the classroom. The pupil focus group also thought that there should be more acknowledgment at the start of the next stage of tech-savvy pupils who are keen to be a resource for staff and pupils.

Overall it was agreed that training in technicalities should be balanced in the next stage by more formal training about classroom management and pedagogical advantage. Some teachers wanted to start action research on the pedagogical value of the devices that are still to be discovered.

Impact Findings

In terms of Guskey's levels the impact on pupils has been greater below the sixth form where they lobbied to be involved. The journals and concept maps submitted indicate a depth, sophistication and level of use of devices that many teachers would find surprising. Personal organisation and research was a major benefit, but distraction in class was a concern of the pupils' who were digital leaders.

From the point of view of staff the barriers or obstacles that are being addressed are: teachers' fears of lack of control or impact on discipline. In this context the teachers wanted to be permitted to decide at any time whether devices are to be used in class, or not. The organiser was also avoiding teachers' feeling overwhelmed. For this reason BYOD was initially limited to 6th form and there is still no enforced curriculum use.

In terms of impact on classroom practice two teachers mentioned particular impacts. A MFL teacher was disturbed by inappropriate exchanges from students abroad in a class project. Another teacher with a Masters in digital technologies and learning who updates his knowledge by belonging to an online teachers' community has been examining his own classroom practice in detail using iPads. He thinks that the potential impact of BYOD/BYOT in facilitating collaborative learning could be as great as the expected impact on independent learning.

In policy terms this teacher ultimately supports a shift to Flipped Classrooms and suggests an action research programme for staff might increase the opportunities to rethink the school's teaching and learning policies. Current assessment is a major barrier to bringing in independent learning, however, in an academically orientated school because experimentation might affect results in the short term.

Study Three: A Prosperous Market Town

This well-resourced 11–16 mixed school of 1500 pupils and 120 teachers specialises in mathematics, ICT, modern foreign languages and sports. In a privileged catchment area there are fewer problem pupils than the national average. Gaining high performing specialist school status in 2009 the school also specialises in special educational needs and gifted and talented education. This school benefits from a well-staffed and well-run Digital Resources Centre including a technician and three dedicated teaching staff. The school is well resourced with 650 machines and devices. Most classrooms have a computer and display equipment supplied by a continuing equipment refreshment programme. A sophisticated combination of in-site and off-site network support ensures network reliability. In addition a high-density wifi Meraki Cloud managed network spreads across most of the school site. As a result of a careful product selection procedure with staff and governors the school has purchased approximately 110 iPad 2 devices for the Pilot. These devices make up two class sets of 32 and also a pilot staff group of over 32 teachers.

Overview of Activity

The project benefits from the oversight of a Senior Leadership Team (SLT) strategist, Director of E-Learning, who is outstanding in computing knowledge, in relating systemic change to pedagogical gain and a talent for communication to staff and pupils. He updates his Masters in Knowledge and Learning Technology by belonging to online professional communities. As a result of his power to make decisions about the infrastructure in the school the BYOD/BYOT project that he has set up has been designed to be one element in the SLT plan to use technology to meet the challenges of the twenty-first century. Those piloting new uses of digital technologies are striving not only to improve motivation but also to establish independent learning and a sense of ownership of the learning agenda. Underpinning these aims are infrastructure decisions like moving to the Cloud using Google solutions are designed to reduce the volume of printing and replace with digital copy or e-learning materials as well as improving work flows. This strategy leverages 5Gb of free personal storage space for each teacher and pupil. The choice of Apple as a strategic partner in mobile devices reflects the prodigious Apps development and the support of the company for education—as well as an element of 'cool' that motivates staff and pupils. The availability of free content in iTunes App store is another benefit: staff authors are already publishing their curriculum e-books as well. The 32 staff iPads have a suite of Apps preloaded that includes curriculum support and a product that permits the use of SIMS on mobile devices including marking class registers and logging behaviour on the go. Sophisticated plans for 1:1 computing devices and universal wifi access that include support for disadvantaged families have already been introduced to parents and staff to inform their purchasing decisions and to avoid a plethora of incompatible devices arriving in school after Christmas.

Analysis and Discussion

The staff agreed that action research undertaken by the teachers is essential if a project that promotes change is to succeed. The viability of the plan was researched over a year and a half by investigating research papers, videos, forum discussions supplier demos, exhibition show products, the E-learning foundation, technology conferences and visits to schools where similar programmes have been implemented.

The iPads pilot fits into a long-term strategy to put more responsibility in the hand of the pupils for learning. Ownership of the iPad has meant that each teacher also experiences more ownership over changing practice from the classroom perspective.

Organisers of similar projects were warned not to underestimate the emergence of technical issues as the project progresses and allow time to sort these out and orientate the technical team to be able to work with new technology in new ways. Advice emerged to communicate sympathetically with parents and staff members who are concerned about league tables and academic rigour. The current assessment environment does not encourage the changes in teaching and learning that are pursued in this project.

Debating about the wider and broader aims of education within the staff was encouraged because at some point the whole staff will want to consider whether they are willing to adjust the theoretical underpinning that informs their professional life and adjust school policies on teaching and learning.

Conclusions

The organiser felt there had been **impact on the school/organisation** because the results of the first pilot was going to be used to make agreed alterations to policies on teaching and learning, appropriate use and e-safety policy.

From the staff there had been no open complaints about the pilot overall although usual concerns were expressed about students forgetting or losing the device. The 32 staff with the first iPads were including pedagogy in their deliberations about the value of these devices. So far motivating reluctant learners, facilitating promoting pride in presentation and encouraging creativity were emerging as outcomes. A well-organised trials plan was communicated in an engaging way to parents who were invited to discuss the results with their children. Subjects where interesting practice was emerging were: PE, Information and Communications Technology and Geography. In History, on teacher said, “A comic strip designer and a book creator App Engaged the student’s creativity whilst keeping them focused on the content of the curriculum. This helped students who are visual learners to remember key terms and concepts more readily’. The development of videos about enzymes in Science was also motivating for ESN pupils.

SEN pupils and students with behavioural problems responded particularly well to the use of iPads as a personal tool.

Science: Using the iPad to make a video about the action of enzymes using paper props was motivating for Special Needs students

Teachers viewed positively the move to use these tools in personal administrative tasks: for example registration and email on the move; note taking; and resource collection. Data was still being collected on the impact on the students because there were requests to extend the project to Year 10 because of parental and student pressure.

> SEN pupils and students with behavioural problems have responded particularly well to the use of iPads as a personal tool.

Pupil reporters for the school news stream found the job easier and pupils in the focus group welcomed opportunities to help the teachers.

Conclusions Across Three Case Studies

Using Guskey's levels the project leaders looked at what kind of impact the project had had and, at what level embedding had taken place in the organisation, amongst the staff and amongst the pupils in their own school as has been recorded already. In presenting the results to each other and to conference groups, it was clear to the project organisers that the results varied widely because of the different contexts and different cohorts and different time scales. In addition different technologies had been used. All the projects were also still in progress but some were more advanced than others.

The first reports on the data had no word limit and remained internal to the school. However, it was important to summarise the three sets of findings in an accessible way so that some conclusions could be drawn about tablets across the three schools. As a result the analysis that was shared was confined to two pages under these headings as above: overview of the school; description of ICT infrastructure and resources, overall infrastructure and resources; specific technologies; overview of project; impact on the organisation, the staff and the pupils; key lessons learnt; recommendations for the future.

Firstly the researcher looked for evidence across the three schools of **the three stages of mobile learning** offered by Pachler et al. (2010). All the tablet users had moved beyond **the first stage of training** to using the devices independently. Although in the first coastal school only a few teachers were involved in using the tablets and ownership of tablets in the school was still low. Some staff still were unhappy about smartphones being used in school although this was a deprived area where many of the families could not afford to provide a tablet. At the City suburb school the group of staff who were now trained and equipped were using the tablets in planned curriculum projects for the sixth form and there was already pressure from younger pupils and their parents to extend the project.

The second stage, concentration on learning outside the classroom, had already been achieved in the first school at the coastal because the pupils had been forced to learn outside their classrooms whilst the new school was rebuilt after the fire. In fact, the presence of any kind of device had been a lifeline in difficult circumstances.

The third stage was the mobility of the learner in mixed reality learning, context-sensitive learning and ambient learning. The schools had not expressed their pedagogical aims as Pachler, Bachmair, Cook and Kress defined them but they had intentions that would change the traditional classroom information transmission model. School one was aiming at independent learning from the start and school two envisaged Flipped Learning as the pedagogy they were aiming at. In this mode of learning pupils would investigate topics outside school and share their conclusions in the classroom. This was only in evidence of the third stage in the rural school where pupils were encouraged to use their iPads to take videos outside the school. The tablet project was most advanced in this school so the fact that they had reached this third stage was predictable.

In the second analysis the MirandaNet Fellows looked at the data from the Guskey perspective looking for impact on students, on staff and on policy.

They found that there are three important implications that stem from this model for evaluating professional development programmes. First, each of the Guskey levels is important: embedding at institutional, staff and student level. The information gathered at each level provides vital data for improving the quality of professional development programmes as well as planning the project. Second, tracking effectiveness at one level does not explain impact at the next level.

The Fellows engaged in this project may in the next stages also take up the advice from the US National Adult Education Pro (2014) that emerged recently, which suggests that schools might plan 'backwards' starting where they want to end and then working back to the strategies to achieve their goals. This is expressed in a series of five considerations:

- The first consideration should be the student learning outcomes that you want to achieve.
- Then it would be determined what instructional practices and policies would most effectively and efficiently produce those outcomes.
- Next, you would want to consider which aspects of organisational support need to be in place for those practices and policies to be implemented.
- Then, decide what knowledge and skills the participating professionals must have to implement the prescribed practices and policies.
- Finally, one would consider what set of experiences would enable participants to acquire the needed knowledge and skills.

Teachers and pupils identified some of the next key questions to be investigated:

- How does the use of personal hotspots by pupils affect responsible use in the school?
- What are the methods for engaging and motivating reluctant teachers to consider changes in their practice?
- What level of on-going support is needed: teacher pedagogical support, technical, student skills etc.
- What should be the balance between informal and formal CPD for teachers?
- How much should the teachers know about pedagogical theory in this area?
- What theories of project management are applicable in this school?

The researcher felt that a knowledge of underlying theory does help with a whole school understanding of what the introduction of digital technologies is trying to achieve. Results were useful for reports for inspectors, governors and in applying for pupil premium grants. All credit to these three schools that have shared their results in order to contribute some ideas to schools who are embarking on introducing tablets.

As a result of this tablets project, MirandaNet Fellows have refined the existing research tools so that iCatalyst CPD participants will have more sophisticated framework for evaluations of CPD in the future. In the first stage, Sprint, the school leaders are mentored whilst they do an audit of how the staff use technology in a programme. This process takes about one or two terms. In the second stage of iCatalyst, called Insight, selected members of staff undertake an action research programme called Insight. Schools would begin by building into strategy the three mobile learning stages from Pachler et al. (2010) and Guskey's five levels (2002) thus ensuring that the project is embedded at organisational, staff and pupil level so that impact can be more easily traced. In response to the feedback from earlier programmes, parents have also been encouraged to join a focus group to provide the leadership team with data.

The project leaders in iCatalyst use every chance to talk with other experts on the strategies they had used in conference and online. MirandaNet is one of the organisations that promotes this kind of intellectual exchange in various events as well as the mirandalink online debating system.

Professor Mike Sharples, a Fellow of MirandaNet, is an international expert on the pedagogies that have developed from mobile learning opportunities (Sharples, 2012–2015). In the mirandalink debate about tablets, he summed up the overall consensus that schools have a responsibility to harness the power of mobile devices for learning.

> This is just one small way to help students 'navigate life' and develop valued and transferable skills. The key is not to let devices rule in school, but to put them into their proper place alongside the other equipment for learning, and to encourage responsible and safe use[12].

Not a revolution then, but thoughtful changes in practice designed to prepare pupils for the future learning.

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Chapter 11
Evaluation of Lesson Plan Authoring Tools Based on an Educational Design Representation Model for Lesson Plans

Stylianos Sergis, Effrosyni Papageorgiou, Panagiotis Zervas, Demetrios G. Sampson, and Lina Pelliccione

Abstract Lesson plans (LPs) are a commonly used method for capturing and disseminating teaching practice within online teachers' communities. Nevertheless, there are no commonly accepted and appropriately designed models for representing LPs. This shortcoming is also mirrored in the existing LP authoring tools, with each of them accommodating a different subset of the overall LP elements. To address this issue, we have proposed an educational Design-driven LP Representation Metadata Model (LPRM) which (a) comprises and extends a range of existing dimensions to model LPs and (b) is structured based on the ADDIE Educational Design Model. Capitalizing on this, the contribution of this chapter is the critical evaluation of a set of widely used LP authoring tools in terms of the level of accommodation they offer for the elements of the proposed LPRM. The findings of evaluation are

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used to highlight shortcomings and to propose guidelines for driving future implementations of LP authoring tools, towards enhancing the capacity of teachers to robustly capture and share their teaching practice.

Keywords Lesson plan • Educational design • Metadata model • Representation model • Lesson plan authoring tool • Evaluation • Teachers • Schools • Authoring tools • Educational design representation model • Teaching communities • Teaching practice • Educational • Design-driven LP representation metadata model • Guidelines for authoring tools

Introduction

In the past decade, a large number of digital repositories have emerged for facilitating teachers to formulate online communities of practice and engage in reflective professional development by sharing (among others) their daily teaching practice (Recker, Yuan, & Ye, 2014; Zervas, Alifragkis, & Sampson, 2014). Within such repositories, the teaching practice is commonly modeled and disseminated in the form of "lesson plans" (LP) (Carroll, Rosson, Dunlap, & Isenhour, 2005), which comprise the detailed description of the teaching and learning process for a lesson, from a teacher's perspective (He, Zhang, Strudler, & Means, 2012; Jacobs, Martin, & Otieno, 2008).

Despite their explicit focus to capture (and disseminate) teaching practice, however, LPs have not been attributed with a commonly accepted representation model that would offer interoperable modeling across repositories and LP authoring tools (Sergis et al., 2015). Moreover, the lack of such a unified representation model is further enhanced given the fact that existing approaches to characterise LPs usually do not offer highly granulated means to transparently depict the teaching practice, since they either characterise them as monolithic learning objects (Kubilinskienė & Dagienė, 2010) or they are not built on a concrete educational design framework (Battigelli & Sugliano, 2009). The aforementioned shortcomings provide significant hindrance to both transparently capturing and representing the teaching practice (usually through LP authoring tools) as well as to effectively disseminating it within teachers' online communities of practice.

To address this issue, an Educational Design-driven Lesson Plan Representation Model (LPRM) has been previously proposed (Sergis et al., 2015). The LPRM is structured on the ADDIE Educational Design Model and comprises and extends a range of existing dimensions for modeling LPs. The proposed LPRM aims to tackle major shortcomings of existing LP characterization methods and, thus, to provide a means for capturing the internal structure of the LPs in a more granulated and transparent manner.

Moreover, the aforementioned LPRM has the potential to be incorporated within *LP authoring tools*. Such authoring tools are addressed at teachers and aim to simplify the lesson planning process (Baylor, Kitsantas, & Chung, 2001). The latter is usually achieved by providing specific input fields for the various characterization elements of a lesson plan (e.g., the educational objectives and the teaching/learning/assessment activities), as well as affording the embedding of multimedia educational resources/tools towards facilitating the LP dissemination process. However, given the aforementioned diversity in the existing characterization methods of LPs, LP authoring tools also do not follow a standard method to model them. This can further hinder the capacity of teachers to effectively capture and share their practice.

Therefore, the main contribution of this chapter is to perform and present a critical evaluation of a set of well-known Lesson Plan authoring tools, based on the Educational Design-driven Lesson Plan Representation Model (LPRM). This evaluation process is steered towards identifying the level of accommodation that existing LP authoring tools offer for the proposed LPRM and highlighting potential shortcomings that could hinder the capacity of teachers to robustly capture and effectively disseminate their LPs. Furthermore, the analysis of the aforementioned shortcomings is utilised to elicit guidelines for the development of LP authoring tools that meet generic educational design considerations and model LPs in a more granulated manner to facilitate future search and retrieval from teachers.

The remainder of the chapter is structured as follows. Section "Background: Lesson Plans" presents the background of the chapter, namely it defines LPs and presents the existing approaches to characterise and describe them. Section "Educational Design Representation Model for Lesson Plans" describes the proposed educational design LPRM (Sergis et al., 2015). Section "Evaluation of existing Lesson Plan Authoring Tools" describes the methodology and results of the evaluation process on a set of LP authoring tools towards highlighting potential shortcomings and generating guidelines for future implementations. Finally, Section "Conclusions and Future Work" concludes the chapter.

Background: Lesson Plans

Definition

Lesson plans (LP) are defined as the detailed description, from a teacher's perspective, of the teaching and learning process for a lesson (i.e., a session of classroom-based flow of teaching, learning, and assessment activities) (Jacobs et al., 2008). LPs have been commonly referred to as being comprised of a set of core elements, namely the educational objectives to be attained in the lesson (Barroso & Pon, 2005; Richards & Schimdt, 2010), the learning and assessment activities to be delivered (Richards & Schimdt, 2010; Whitton, Sinclair, Barker, Nanlohy, & Nosworthy, 2004), as well as the educational resources and tools that will support the delivery of these activities (Richards & Schimdt, 2010; Van Es & Koper, 2005). The core elements signify the generic focal point of LPs, which is to provide a blueprint of a teacher's actions during the day-to-day classroom teaching practice (Jacobs et al., 2008), towards (among others) facilitating the teacher to design, deliver, and share their lessons (Whitton et al., 2004).

Apart from the aforementioned core elements, however, LPs have been attributed with a wider range of characterization elements which aim to capture various aspects of the teaching and learning process and, thus facilitate the teacher to depict (and, therefore, deliver) it in a more effective manner (Butt, 2008). The exact characterization elements used to model LPs (e.g., in repositories or LP authoring tools), however, can be significantly variant and, often, inadequate (Sergis et al., 2015). The following section presents an analysis of the existing LP characterization elements in order to provide a basis to present the unified LP Representational Model.

Existing Characterization Elements

An analysis of 20 approaches to characterise LPs was performed, towards eliciting the characterization elements utilised by them (Sergis et al., 2015). The utilised approaches were selected from both the scientific literature and widely used practice-oriented LP repositories, towards capturing their different standpoints to LP characterization. Table 11.1 presents the resulting characterization elements used for describing LPs, as they were derived from the aforementioned analysis. For each characterization element, Table 11.1 also presents the occurrence percentage, i.e., the aggregated percentage in which this element was identified.

Table 11.1 Existing lesson plan characterization elements

#	Characterization element	Occurrence percentage	#	Characterization element	Occurrence percentage
1	Title	100 %	12	Teachers' prerequisite competences	15
2	Author	55 %	13	Students' prerequisite competences	35
3	Summary	65 %	14	Student accessibility issues	30
4	Keywords	30 %	15	General educational objectives addressed	50
5	Educational problem	20 %	16	Specific educational objectives addressed	95
6	Age Range/Grade level	90 %	17	Teaching approach	30
7	Duration	65 %	18	Flow of learning activities	100
8	Subject domain	95 %	19	Flow of assessment activities	90
9	Subject domain topic	40 %	20	Assessment method/type utilised	10
10	Educational standards addressed	70 %	21	Teacher reflection/lesson adaptations	85
11	Educational resources—tools used	85 %			

As Table 11.1 depicts, a set of recurring characterization elements for representing LPs can be identified (i.e., occurrence frequency above 50 %). As this subset signifies, many of the existing approaches to model LPs have a limited scope. More specifically, they focus on facilitating teachers to explicitly capture only a set of the aspects related to capturing their lesson, i.e., the aspects that are more addressed at providing them with a blueprint guide to deliver their day-to-day practice. This is consistent with the characteristics of LPs provided in the "Introduction" Section, i.e., that LPs are primarily focused on describing a strict set of lesson dimensions from a teacher's perspective.

As previously argued, though, such a restrictive approach to model the teaching practice (in terms of the representation elements commonly utilised) can hinder both the teachers' own capacity to plan their lessons concretely and their capacity to effectively and transparently share it with other practitioners. Therefore, teachers would benefit from a unified and educational design-driven method to allow them to transparently and robustly capture their teaching practice, in order to both be facilitated in delivering it themselves and be able to disseminate it effectively to other peer practitioners.

The following section, therefore, presents the LP Representation Model, which offers a unified and Educational Design-driven method to represent LPs in a more granulated and structured manner. In this chapter, the LPRM will provide the basis for the evaluation of the existing LP authoring tools, towards identifying shortcomings in their functionalities which could hinder teachers from robustly capturing (and sharing) their teaching practice.

Educational Design Representation Model for Lesson Plans

Based on the previous section, Table 11.2 presents the proposed LPRM, which was introduced recently in a study by Sergis et al. (2015). As mentioned previously, the LPRM aims at explicitly tackling the shortcomings of existing approaches to representing LPs, by incorporating the superset of the representation elements and capturing the internal structure of LPs towards providing a highly granulated representation of the LPs. Moreover, as Table 11.2 depicts, the identified superset of representation elements for LP has been reorganised and adapted in order to adhere to the 5 (sub-) phases of the well-known ADDIE Educational Design Model, i.e., Analysis, Design, Develop, Implement and Evaluate (Branch, 2010; Dick & Carey, 2001). Therefore, the LPRM offers a higher level of detail in terms of the educational design considerations of LPs, compared to the ones depicted for narrow content-oriented LO descriptions (Sampson, Zervas, & Sotiriou, 2011), and, thus, can facilitate accurate and consistent LPs representation across digital repositories towards more efficient search and dissemination.

Furthermore, in order to populate specific representation elements of the LPRM with a "closed vocabulary" value space, the existing taxonomies of a major European project, namely Open Discovery Space (ODS) [http://www.opendiscoveryspace.eu],

Table 11.2 Proposed educational design representation model for lesson plans

ADDIE phase	ADDIE subphase	Representation element	Description	Value type
General metadata elements	–	Title	The title of the lesson	LangString
		Summary	A summarizing description of the lesson	LangString
		Author	The teacher who designed the lesson	LangString
		Keywords	Keywords describing core aspects of the lesson	LangString
		Copyrights	Potential copyright restrictions for the lesson	CC Licence[a]
Analysis	A1. Educational problem identification	A1. Educational problem	The educational problem that the lesson is addressing	LangString
	A2. Contextual analysis	A2.1 Duration	The expected duration of the lesson (in hours)	Numerical
		A2.2 Teacher's prior competences	Prerequisite teachers' competences for delivering the lesson	UNESCO Framework[b]
		A2.3 Required infrastructure	The technical/physical infrastructure for delivering the lesson	LangString
	A3. Learner analysis	A3.1 Age range/Grade Level	The appropriate age range/Grade level of the students	Numerical
		A3.2 Language	The language of the lesson to be delivered	ODS Taxonomy[c]
		A3.3 Students' prior Competences	Potential prerequisites in terms of students' competences	LangString
		A3.4 Accessibility issues	Potential accessibility needs of the students	ODS Taxonomy[d]
Design	DES 1. Definition of educational objectives	DES1.1 Subject domain	The subject domain(s) of the lesson	ODS Taxonomy[e]
		DES1.2 Topic domain	The subject domain topics of the lesson	
		DES1.3 General learning outcomes	The general and specific educational objectives addressed in the lesson. Each educational objective should be "codified" (i.e., be assigned a unique decimal ID) in order to allow for referencing from other elements (e.g., teaching/learning/assessment activities)	ODS Taxonomy[f]
		DES1.4 Specific educational objectives		LangString
		DES1.5 Educational curriculum standards	Specific (Inter)National educational curriculum standards (such as Common Core) addressed	LangString

	DES 2. Selection of teaching approach/strategy	DES2.1 Teaching approach	The teaching approach utilised in the lesson	ODS Taxonomy [g]
		DES2.2 Flow of teaching/learning/assessment activities	The flow of teaching/learning/assessment activities in the lesson and their mapping to specific educational objectives. Their depiction is performed in a tabular form. Each row of the table includes the description of one teaching/learning/assessment activity and is complemented (in separate columns) by its unique ID code—incremental decimals—and the ID of the educational objective is supports	LangString
	DES 3. Selection of assessment method(s)	DES3.1 Assessment type(s)	The assessment type(s) used in the lesson (e.g., diagnostic assessment, summative assessment)	ODS Taxonomy[h]
		DES3.2 Assessment method(s)	The assessment method(s) used in the lesson, i.e., the method of assessment used in each assessment activity (e.g., Multiple Choice quiz, Debate etc.). These aspects can be incorporated in separate columns in the table used for DES2.2	LangString
Develop	DEV 1. Development or selection of educational resources	DEV1. Educational resources	The educational resources, tools, and services exploited in the lesson mapped to the specific teaching/learning/assessment activities they support. These aspects are incorporated in the table used for DES2.2 (i.e., by incorporating additional columns for each teaching/learning/assessment activity)	LangString
	DEV 2. Development or selection of educational tools and/or services	DEV2.1 Educational tools		LangString
		DEV2.2 Required services		LangString
	DEV 3. Development/arrangement of the delivery setting	DEV3. Development/arrangement of the appropriate delivery setting	Potential arrangements/alterations of the physical space in order to effectively support the needs of the lesson	LangString

(continued)

Table 11.2 (continued)

Implement	–	–	These elements are not captured in the LPRM because they are related to the actual real-time *delivery* of the lesson	–
Evaluate	E1. Formative evaluation			
	E2. Summative evaluation	E2.1 Adaptations/extensions	Potential alterations from the teacher based on educational data and/or experiences collected in prior deliveries. The description of these alterations are in "free-text" format, and the unique IDs of the teaching/learning/assessment activities can be referenced in order to specifically refer to the part of the lesson in which adaptations/extensions were made.	LangString
		E2.2 Teacher's reflection	Reflection focusing on the evaluation results of both the students and the lesson (provided by the students). Teachers' reflections can be introduced similarly as in E2.1	LangString

[a]Retrieved June 5, 2016, from https://goo.gl/5B63Q
[b]Retrieved June 5, 2016, from http://goo.gl/oKUkB
[c]Retrieved June 5, 2016, from http://goo.gl/37BhV2
[d]Retrieved June 5, 2016, from http://goo.gl/MI5T2R
[e]Retrieved June 5, 2016, from http://goo.gl/2uMi3B
[f]Retrieved June 5, 2016, from http://goo.gl/haLB34
[g]Retrieved June 5, 2016, from http://goo.gl/AjEuel
[h]Retrieved June 5, 2016, from http://goo.gl/C770wJ

were exploited. The use of closed vocabularies for a wide set of representational dimensions can facilitate the LP storing and searching capabilities of digital repositories of teachers' online communities.

As Table 11.2 depicts, the LPRM covers the full spectrum of existing elements to characterise LPs and, furthermore, extends them following the requirements of the ADDIE Model towards providing a detailed representation model for LPs. More specifically, the LPRM accommodates the foundational representation elements of LPs (deriving from their definition analysis in section "Definition"), namely educational objectives, the flow of (teaching) learning and assessment activities, as well as educational resources and tools. In addition, it also explicitly incorporates representational elements aiming to captivate elements of the educational design that can greatly affect the delivery of the lesson, such as the required teacher (and student) competences, the infrastructural requirements, and the prior experiences and adaptations of the teacher(s) that have already delivered the lesson within particular contexts (which are also captured in the LPRM). The added value of the latter is especially significant when considered beyond the context of guiding a teacher's own daily practice, and placed within the context of dissemination in teachers' online communities of practice.

In order to facilitate teachers to perform the aforementioned process of formulating, modeling, and disseminating LPs, LP authoring tools have been implemented (e.g., He & Wang, 2008; Wang & Wedman, 2003). These commonly used authoring tools aim to provide support (e.g., pre-existing representation element fields to be completed, use of taxonomies to populate representation elements capacity to embed educational resources/tools) to teachers during the usually cumbersome task of planning their lessons transparently and robustly (Baylor et al., 2001). Therefore, the level of granularity that these tools offer the teachers to represent their LPs can potentially affect the capacity of the peers in the online teacher community to review and select the most appropriate LP for their own setting and needs. The latter is even more evident considering the aforementioned diversity in the manner in which LP are being characterised and represented.

Under this light, the following section aims to perform an evaluation of a set of well-known LP authoring tools and draw conclusions on their capacity to actually facilitate teachers to robustly depict their teaching practices, i.e., by accommodating the proposed unified and educational design-driven LPRM. Moreover, based on the findings of this evaluation process, design guidelines are proposed in order to drive the development of future LP authoring tools which will afford more granulated methods for representing LPs.

Evaluation of Existing Lesson Plan Authoring Tools

Evaluation Methodology

A functionality-focused approach was selected for driving the critical analysis process, i.e., the sample of selected LP authoring tools was assessed solely on the premises of their functionalities' capacity to accommodate the proposed LPRM. Therefore, each authoring tool was accessed and extensively reviewed in terms of its functionalities to

Table 11.3 Sample of 15 lesson plan authoring tools

Code	LP authoring tool	URL	Code	LP authoring tool	URL
[1]	Lesson Writer	http://goo.gl/M81Bo	[9]	CAST-UDL Exchange	http://goo.gl/kadTms
[2]	PlanBookEdu	http://goo.gl/kyk9R	[10]	CorePlanner	http://goo.gl/EtpXZB
[3]	Planboard	http://goo.gl/ki9tl	[11]	Achieve the Core	http://goo.gl/zz552r
[4]	Common Curriculum	http://goo.gl/5so16	[12]	Teach-nology LP Maker	http://goo.gl/RN4J1F
[5]	Learnboost	https://goo.gl/xjWN	[13]	BlendSpace	https://goo.gl/44GiwP
[6]	Standards Toolbox	http://goo.gl/CxyBPW	[14]	iLessonReady	https://goo.gl/SsGLuO
[7]	My Lesson Planner	http://goo.gl/EBret6	[15]	Teachers.io	http://goo.gl/AMrCy9
[8]	UEN LP Tool	http://goo.gl/bXfLDT			

fully support the LPRM elements, as they have been defined in section "Educational Design Representation Model for Lesson Plans." Other assessment methods, such as subjective measures (e.g., user satisfaction or perceived efficiency of the authoring tool), were not considered in this process.

Regarding the selection criteria utilised for formulating the list of LP authoring tools to be analyzed, a threefold set was utilised, namely (a) the authoring tool should be an already deployed system, i.e., not simply a design, (b) the authoring tools should be addressed specifically at lesson planning (i.e., not learning design in general), and (c) the authoring tools should offer free (or demo/free trial) access. Adhering to these three selection criteria, a set of 15 existing LP authoring tools were identified via web search using the Google search engine.

Table 11.3 presents the list of the selected authoring tools.

Finally, regarding the procedure of the evaluation analysis (i.e., the steps taken for evaluating each LP authoring tool), it comprised assessment in terms of the cardinality of LPRM representational elements that the LP authoring tool accommodated fully and explicitly. Ultimately, the insights gained from this evaluation process could generate guidelines for the design and deployment of future LP authoring tools that will provide teachers with functionalities to allow for more granulated depictions of their teaching practices.

The results of the critical evaluation process are presented in the following section.

Evaluation Results

This section presents the evaluation of the sample of LP authoring tools in terms of the level of accommodation that they offer for the elements of the proposed LPRM. Table 11.4 depicts the findings from the evaluation process, namely the

Table 11.4 Evaluation of lesson plan authoring tools against the proposed LPRM

#	LPRM element	Lesson plan authoring tool	#	LPRM element	Lesson plan authoring tool
1	Title	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15]	15	DES1.2 Topic domain	[1], [3], [4], [5], [7], [9], [10], [11], [12]
2	Summary	[1], [2], [4], [8], [9], [12], [13], [15]	16	DES1.3 General learning outcomes	[1], [4], [5], [7], [8], [9]
3	Author	[1], [3], [4], [5], [7], [8], [10], [11], [12], [13], [14], [15]	17	DES1.4 Specific educational objectives	[1], [2], [3], [4], [5], [7], [8], [9], [10], [11], [12], [13], [14], [15]
4	Keywords	[1], [5], [7], [8]	18	DES1.5 Educational curriculum standards	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [13], [14]
5	Copyrights	[6]	19	DES2.1 Teaching approach	[7], [9]
6	A1. Educational problem	[1], [8], [10], [13]	20	DES2.2 Flow of teaching/learning/assessment activities	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15]
7	A2.1 Duration	[2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [13], [14], [15]	21	DES3.1 Assessment type(s)	[9]
8	A2.2 Teacher's competences	[8]	22	DES3.2 Assessment method(s)	[5], [6], [7], [13]
9	A2.3 Required infrastructure	[9], [12]	23	DEV1. Educational resources	[1], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15]

(continued)

Table 11.4 (continued)

#	LPRM element	Lesson plan authoring tool	#	LPRM element	Lesson plan authoring tool
10	A3.1 Age range/ Grade Level	[1], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [15]	24	DEV2.1 Educational tools	[1], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14]
11	A3.2 Language	[1], [2], [3], [4], [7], [10], [13]	25	DEV2.2 Required services	[8], [12]
12	A3.3 Students prior competences	[8], [9], [11]	26	DEV3. Development/arrangement of the appropriate delivery setting	[5]
13	A3.4 Accessibility issues	[1], [6], [8], [9], [12]	27	E2.1 Adaptations/extensions	[4], [6], [7], [8], [9], [11]
14	DES1.1 Subject domain	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10],[11], [12], [13], [14], [15]	28	E2.2 Teacher's reflection	[2], [3], [4], [5], [7], [9], [11], [12]

specific LP authoring tools (using the codification of Table 11.3) that fully and explicitly accommodate each of the LPRM elements.

Figure 11.1 presents the consolidated evaluation results (i.e., occurrence frequencies) on the level of accommodation that each LPRM element is receiving from existing LP authoring tools.

As Fig. 11.1 depicts, the level of accommodation (i.e., occurrence frequency) of the aforementioned focal points of lesson plans is consistently high. More specifically, general metadata fields related to the "Title" and the "Author" of the LP are accommodated in a very high degree, namely $x=100\,\%$ and $x=80\,\%$ respectively. Additionally, there is a clear focus towards accommodating the *core elements* of the LPs as they were outlined in section "Definition," namely the (specific) educational objectives to be attained ($x=93\,\%$), the (flow of) learning and assessment activities to be delivered ($x=100\,\%$), as well as the educational resources and tools that will support the delivery of the aforementioned activities ($x=93\,\%$ and $x=87\,\%$, correspondingly). Therefore, this is consistent with the foundational definition of LPs adopted in this chapter. Additionally, representation elements related to the previous

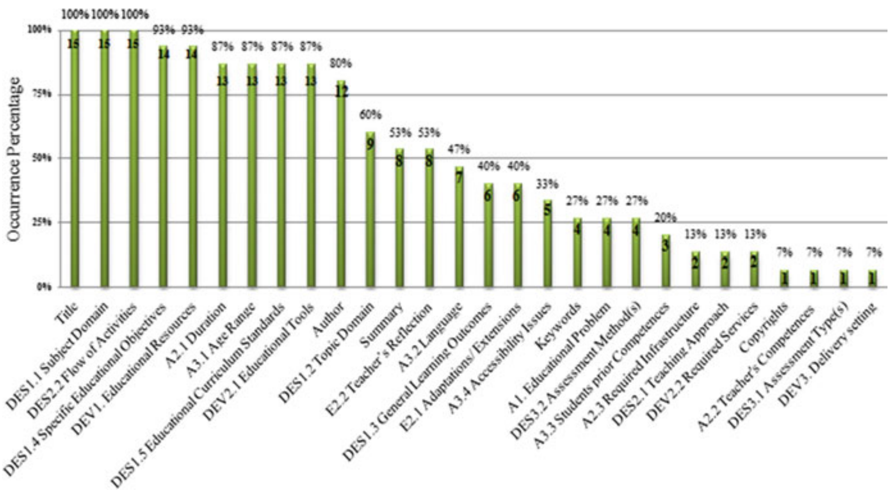

Fig. 11.1 Consolidated evaluation results of the level of accommodation of the LPRM elements from the selected LP authoring tools

ones are also consistently accommodated in a high degree, i.e., the subject domain ($x=100\,\%$), the age range/grade level appropriate for the lesson ($x=87\,\%$), the duration of the lesson ($x=87\,\%$), and the educational standards addressed ($x=87\,\%$).

In contrast to the high level of accommodation for the aforementioned representation elements, the analysis process revealed that a wide range of LPRM elements are not sufficiently accommodated. More specifically, the evaluation of the existing LP authoring tools highlighted a set of key findings which can be used for the elicitation of guidelines for future implementations of LP authoring tools. These findings, and their corresponding resulting guidelines, are described as follows:

- *Limited accommodation for a wide range of LPRM elements*. More specifically, Fig. 11.1 clearly depicts the fact that a set of 15 of the proposed LPRM elements (54 % of the LPRM cardinality) are seldom or rarely accommodated (i.e., occurrence frequency lower that 50 %). This is an important finding considering the importance of the LPRM elements which are included in this set in terms of the educational design of the lesson (not considering "Language," "Summary," "Keywords," and "Copyrights" which can be considered as general metadata elements).

  More specifically, a careful analysis of these elements highlights the fact that most of them do not specifically focus on facilitating the teachers to plan their day-to-day practice, but have a more general scope, which aims at describing the teaching practice from a more granulated perspective. For example, such elements include (a) the "Educational Problem" ($x=27\,\%$), (b) the "General Learning Outcomes" ($x=40\,\%$), (c) the "Teaching Approach" ($x=13\,\%$), (d) the required infrastructure for delivering the lesson ($x=13\,\%$), and (e) students' and teachers' prerequisite competences ($x=20\,\%$ and $7\,\%$, respectively). Additionally, it was typical for elements such as the assessment methods and assessment types to be merged in the flow of assessment activities and not be explicitly defined. This is an important shortcoming, since the aforementioned elements are essential aspects of the educational design of the lesson and can greatly affect its delivery.

From the previous findings, it is evident that the existing LP authoring tools are more focused on facilitating teachers to plan their *own* day-to-day practice; therefore they do not adequately accommodate representation elements that the teachers might consider to be "taken for granted" in their specific context of work. For example, the "Required Infrastructure" for delivering the lesson is not a consideration for the teacher, since the available infrastructure is "static" for him. However, these representation elements can be of crucial importance for other practitioners when the LPs are shared in online communities of practice. More specifically, teachers should be able to review (a) the detailed description of the LP, but also (b) the context in which the actual lesson was delivered, and (c) potential reflections on/outcomes of the lesson within this particular context. Such a highly granulated depiction can allow teachers to retrieve (and reuse) those LPs that are not only relevant to their subject domain knowledge-related needs, but have also been successfully delivered and "reviewed" in contexts and educational settings similar to their own.

Guideline 1: LP authoring tools should explicitly accommodate the full spectrum of the educational design-related LPRM elements, in order to increase the capacity of a teacher to formulate robust teaching interventions.

This granulated depiction of LPs (at the design process level) can facilitate teachers to plan their practice in much more detail and, thus, be able to more effectively foresee and address potential problems that could occur at the delivery time. For example, without having explicitly considered and defined the required infrastructural needs for the lesson, the teacher might face critical incidents during the delivery, if the school's ICT hardware was inappropriate to accommodate the requirements of the resources of the lesson.

Furthermore, as previously argued, the transparent modeling of LPs offered by LPRM can also facilitate search, selection, and reuse of appropriate LPs by teacher practitioners, based on their own educational context and needs.

- *Limited accommodation of mappings within LP elements*. This functionality-based shortcoming was consistent for all the selected LP authoring tools. More specifically, the LPRM argues towards moving beyond the isolated depiction of (a) the flow of learning/teaching/assessment activities, (b) the educational resources that support them, and (c) the educational objectives they aim to facilitate to attain. Presenting a clear mapping (at least) between the aforementioned elements can facilitate teachers reviewing the LP (including the author teacher) to have a more transparent depiction of both the level in which the principles of constructive alignment (Biggs, 1996) have been achieved and the exact manner in which the delivery of the lesson is planned to be performed.

Guideline 2: LP authoring tools should explicitly accommodate functionalities related to the codification and cross-referencing of the aforementioned LPRM elements, towards allowing the teacher to map them to each other, and thus, clearly depict the connection between them.

- *Representation of specific LPRM elements with taxonomy value spaces*. This shortcoming is related to the resulting inefficiency of the characterised LPs to be effectively searched and reviewed by teachers in online communities of practice. More specifically, existing LP authoring tools should aim at characterizing specific representation elements of LPs (as indicated in the LPRM) by utilizing "closed vocabulary" taxonomies.

  These taxonomies should be based on commonly accepted (inter-)national standards related to the specific representation element to be populated.

A relevant analysis of the existing authoring tools indicated that the aforementioned approach is almost universally accommodated regarding the "Educational Curriculum Standards" elements, since 93 % (i.e., $N = 13$ out of 14 authoring tools) of the authoring tools that accommodate this representation element provide existing taxonomies (e.g., Common Core Standards[1]). Regarding other representation elements, the (general) educational objectives to be addressed were explicitly codified in a small fraction of the sample, namely in 3 authoring tools ([1], [2], [7]). These tools exploited an existing taxonomy, i.e., Bloom's revised taxonomy of educational objectives (Anderson & Krathwohl, 2001). Finally, regarding the "Teaching Approach" and "Assessment Methods," despite their overall limited level of accommodation, within the small set of LP authoring tools that did accommodate them, they were codified using a closed taxonomy (although unique to each authoring tool) in a relatively high degree, namely $x = 50$ % (authoring tool: [7]) and $x = 75$ % (authoring tools: [5], [6], [7]) respectively.

Other LPRM elements are consistently modeled using mainly free text fields, thus limiting the capacity of the teachers to effectively search for LPs using such elements as filters.

Guideline 3: LP authoring tools should explicitly utilise existing taxonomies to represent specific LPRM elements, allowing for enhanced searching and retrieval capabilities for teachers.

This section presented the methodology employed and insights gained from the evaluation process of the existing LP authoring tools against the proposed LPRM. The set of guidelines that was elicited from this process could potentially be incorporated in future LP authoring tools as well as digital repositories of LPs, in order to provide an interoperable and robust method to model teaching practices. Given the significant focus of teachers on these online communities towards having access to peers and collective knowledge (Sampson & Zervas, 2013), facilitating the

[1] Retrieved June 5, 2016, from http://www.corestandards.org/.

participating teachers to effectively build and share this knowledge can provide them with an important scaffold during their continuous endeavor for professional development.

Conclusions and Future Work

In the context of teacher online communities, practitioners are usually engaged in continuous professional development through the modeling and dissemination of their teaching practices in the form of LPs. Given that the level of granularity and diversity in the manner in which these LPs are modeled can significantly affect the capacity of the teachers to search and locate those most appropriate to their own needs, this chapter originated from the presentation of an Educational Design-driven Lesson Plan Representation Model, originally introduced recently in a study by Sergis et al. (2015). The LPRM aims at providing a granulated method to depict LPs by (a) exploiting a superset of existing dimensions for representing LPs from both the scientific literature and practice-oriented standpoints and (b) appropriately structuring and extending this superset based on the considerations imposed by the ADDIE Educational Design Model.

Building on the LPRM, this chapter focused on performing a functionality-based evaluation of a set of existing LP authoring tools, which are commonly used by teachers in order to model (and then share) their LPs. This evaluation was performed in order to gain insights on the LP representation elements currently used in LP authoring tools and to highlight potential shortcomings that could hinder teachers from robustly capturing their teaching practice when using these LP authoring tools.

The outcomes of this evaluation process signified that existing LP authoring tools offer limited support to teachers in terms of accommodating, mapping, and representing a wide range of LPRM elements, thus impeding their capacity to robustly depict and share their teaching practice with their peers in online communities of practice. Moreover, the findings from the evaluation process were translated in guidelines which could drive potential future work in this area, i.e., the design, implementation, and evaluation of LP authoring tools which will tackle the identified shortcomings of the existing LP authoring tools. By fully incorporating the proposed LPRM and accommodating the shortcomings of existing LP authoring tools, such implementations could allow for more transparent and granulated depiction of the teaching practices, thus facilitating their dissemination within teachers' online communities.

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Chapter 12
Implementing Teaching Model Templates for Supporting Flipped Classroom-Enhanced STEM Education in Moodle

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Abstract Science, Technology, Engineering, and Mathematics (STEM) Education has been associated with the need for cultivating students' inquiry and problem-solving skills by exploiting appropriate student-centered teaching approaches. At the same time, the Flipped Classroom (FC) model has been proposed as a blended learning means to enhance such teaching approaches by effectively reallocating their learning activity distribution towards maximizing student engagement and scaffolding by the teachers. In order to reap the benefits of FC-enhanced teaching approaches when designing and delivering their STEM learning interventions, however, teachers (especially novices) could benefit from having access to "generic" teaching model templates that they can adjust in their specific needs. In this context, we have introduced a set of FC-enhanced teaching model templates focusing on two widely used STEM-appropriate teaching models, i.e., the Inquiry- and Problem-based teaching models. Capitalizing on this, the contribution of this chapter is the

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presentation of the implementations of the aforementioned teaching templates in Moodle, a widely used open source Learning Management System. The anticipated added value of the proposed adaptable Moodle templates is to provide support to (novice) STEM teachers, not only in their educational design (through the use of the proposed FC-enhanced teaching model templates), but also in the delivery of their lessons and/or educational scenarios.

Keywords Flipped classroom • Teaching model templates • Moodle • STEM education • Templates • Teaching models • Inquiry- and problem-based teaching models • Open source • Learning management system • Support • STEM teachers • Educational design • Content delivery • Lessons • Teaching context

Introduction

Science, Technology, Engineering and Mathematics (STEM) education is commonly recognised as a major priority for school education globally (European Commission, 2007; Johnson, Adams Becker, Estrada, & Martín, 2013). During the past years, STEM education has been challenged by the cultivation of specific student skills, including (among others) inquiry and problem-solving (European Commission/EACEA/Eurydice, 2012; Freeman, Marginson, & Tytler, 2015).

In order to address these needs, student-centered approaches (such as the Problem- and Inquiry-based teaching approaches) are being increasingly considered and adopted (Pedaste et al., 2015; Sayary, Forawi, & Mansour, 2015). In addition, blended-teaching models, such as the Flipped Classroom (FC) model (Bergmann & Sams, 2012), are being deployed in the context of STEM Education to enhance these student-centered teaching approaches in order to better meet the aforementioned STEM foci (Baepler, Walker, & Driessen, 2014; Chen, Wang, & Chen, 2014).

In this context, and considering the novelty of the FC model, teachers (especially novices) could benefit from having access to teaching model templates for supporting the design and delivery of FC-enhanced STEM lesson plans and educational scenarios. A first step to address this issue was introduced in our previous work, namely the design of two FC-enhanced teaching model templates, based on widely used teaching models in the context of STEM education (Sergis et al., 2015). The selected teaching models were the Inquiry-based teaching model and the Problem-based teaching model, due to the fact that they have been identified as appropriate for addressing the emerging needs of STEM education (European Commission, 2007). More specifically, the proposed templates aimed at facilitating the teachers in a twofold manner. First, by providing a "generic", structured and adaptable blueprint of the teaching, learning and assessment activity types within the specific phases of the two teaching models. Second, they incorporated the standpoints of the FC model in terms of the distribution of the teaching, learning and assessment activities between the teacher-supported face-to-face classroom and/or lab-based sessions and the student-led "homework" sessions.

Further capitalizing on the aforementioned work, the contribution of this chapter is to provide a second layer of support to STEM teachers, by reporting on the design and implementation of the aforementioned set of Flipped Classroom Teaching Model templates in the widely used Learning Management System Moodle.[1] These adaptable Moodle-based template implementations aim at facilitating teachers to not only design (through the use of the proposed FC teaching model templates), but also directly deliver their lessons and/or educational scenarios to their students.

The remainder of the chapter is structured as follows. Section “Background” presents the background of the chapter, namely it describes the Flipped Classroom Model and outlines its benefits in terms of supporting the emerging needs of STEM education. Section “Design of the Flipped Classroom Teaching Model Templates” describes the proposed design of the FC-enhanced teaching model templates, based on the widely used Inquiry-based and Problem-based teaching models (Sergis et al., 2015). Section “Implementation of the Flipped Classroom Teaching Model Templates in Moodle LMS” presents the implementation of the aforementioned templates in the Moodle LMS, towards providing STEM teachers with a generic template for instantiating and delivering their FC-enhanced STEM lessons or educational scenarios. Finally, section “Conclusions and Future Work” concludes the chapter.

Background

Flipped Classroom Model

The FC model is a blended teaching model, namely it divides the learning interventions to be delivered between (partly) self-regulated online sessions and teacher-supported, face-to-face sessions (Staker & Horn, 2012). The main standpoint that guides the aforementioned distribution of the sessions is the optimal exploitation of the face-to-face classroom and/or lab time (Bergmann & Sams, 2012).

More specifically, the FC model posits the key notion that teacher-supported face-to-face sessions should not be spent on delivering lectures, but rather on engaging students in (teacher-supported) “hands-on” (possibly collaborative) activities promoting active engagement, scaffolding and feedback (Chen et al., 2014; Fulton, 2012). The underlying principle that commonly guides the distribution of teaching, learning and assessment activities in a FC-enhanced lesson and/or educational scenario is that basic content delivery (i.e., the main focal point of lectures) does not necessarily need to be delivered by the teacher, who can be substituted by appropriately designed/selected educational and assessment resources (e.g., educational videos and quizzes) (Bishop & Verleger, 2013). In that way, students can engage with these resources in an autonomous manner and, thus, have a higher degree of freedom in terms of learning pace and time. On the contrary, teacher-supported face-to-face sessions can provide students with unique learning experiences through the

[1] Retrieved June 5, 2016, from https://moodle.org/.

direct access to both their classmates (for engaging in collaborative activities) as well as to feedback and scaffolding by their teacher (Chen et al., 2014).

Due to its aforementioned characteristics, the FC model has been proposed and exploited within the context of STEM Education, in order to enhance existing teaching and learning practice (Herreid & Schiller, 2013), as discussed in the following section.

Flipped Classroom Model for Supporting STEM Education

An increasing body of research has emerged towards investigating the level in which the FC model can enhance the existing teaching approaches exploited in the STEM context and better address the aforementioned needs of cultivating students' inquiry and problem-solving skills. More specifically, the FC model has been attributed with increasing the level of students' active engagement in the learning process (Baepler et al., 2014; Deslauriers, Schelew, & Wieman, 2011) and shifting the focus of the teacher-supported sessions to fostering collaborative and problem-solving activities (Clark, 2015; Mason, Shuman, & Cook, 2013). Moreover, the FC model has been shown to deliver better learning outcomes, in terms of the students' attainment of the learning objectives related to the subject matter (Davies, Dean, & Ball, 2013; Day & Foley, 2006). Finally, evidence has also shown that the FC can lead to better student attitudes towards STEM (Fautch, 2015; Wilson, 2013), as well as better learning experiences, as defined by the students themselves (Davies et al., 2013; Love, Hodge, Grandgenett, & Swift, 2014).

Based on the above, it is becoming increasingly evident that the FC model has the potential to be incorporated within existing teaching approaches in STEM, to further enhance their effectiveness. However, considering the novelty of the FC model, (novice) teachers could benefit from having access to "generic" and adaptable design blueprints to facilitate them in designing and delivering their FC-enhanced lessons and/or educational scenarios. In previous work, such "generic" teaching model templates based on commonly accepted STEM-appropriate teaching models, further enhanced with the FC model were proposed (Sergis et al., 2015). The proposed FC-enhanced templates were based on two widely used teaching models in the context of STEM education, namely the Inquiry-based Teaching Model and the Problem-based Teaching Model (European Commission, 2007).

Furthermore, to assist teachers for not only designing, but also delivering their STEM lessons and/or educational scenarios, this chapter builds on the aforementioned FC-enhanced teaching model templates and presents their implementation in the widely used Moodle LMS. The following section discusses the previously introduced "generic" teaching model templates towards providing the basis for the presentation of their Moodle-based deployment in section "Implementation of the Flipped Classroom Teaching Model Templates in Moodle LMS".

Design of the Flipped Classroom Teaching Model Templates

Inquiry-Based Flipped Classroom Teaching Model Template

The Inquiry-based (IB) teaching approach reflects an exploratory approach to teaching and learning, promoting students' active participation and self-regulated discovery of knowledge (Pedaste et al., 2015). More specifically, it posits the notion that students should be allowed (and guided) to create their own reasoning on real-life problems and phenomena, by adhering to scientifically appropriate methodologies and techniques (Sharples et al., 2015; van Joolingen & Zacharia, 2009). In the context of STEM education, there is emerging understanding that the IB approach can effectively deliver a set of benefits directly related to the emerging needs. More specifically, prior work with exploiting the IB approach has shown a significant positive influence (among others) on the students' (a) attainment of educational objectives related to the subject domain (Crawford, 2012; Hwang, Wu, Zhuang, & Huang, 2013), (b) level of motivation (Donnelly, Linn, & Ludvigsen, 2014; Tuan, Chin, Tsai, & Cheng, 2005) and engagement (Tsai & Tuan, 2006), as well as (c) the cultivation of problem-solving competences (Gillies, Nichols, Burgh, & Haynes, 2014). Therefore, the IB approach (and the relevant teaching model—IBM) can be considered as appropriate for supporting the emerging needs of STEM education, and thus, was used for formulating a FC-enhanced template.

The structural representation of the IBM adopted in this chapter is an adaptation of the relevant models proposed by Bell, Urhahne, Schanze, and Ploetzner (2010) and Bybee et al. (2006). It comprises five Phases, which are presented as follows:

- *Phase 1: Orienting/Asking Questions*. Phase 1 involves the presentation of the problem to be investigated and aims to provoke curiosity.
- *Phase 2: Hypothesis Generation & Design*. Phase 2 involves the formulation of initial hypotheses from the students based on their own reasoning and current understanding of the problem.
- *Phase 3: Analysis & Interpretation*. Phase 3 involves the analysis and organization of the research/experimentation processes and the related tools/resources that will facilitate them. These can be discovered by the students or be provided by the teacher.
- *Phase 4: Planning and Investigation*. Phase 4 engages students in experimentations exploiting the processes and tools/resources outlined in Phase 3.
- *Phase 5: Conclusion and Evaluation*. Phase 5 includes reflective analysis of the students' initial hypotheses based on the experimentation results and formulation of a final common solution.

Based on the adopted conceptualization of the IBM, Table 12.1 presents the proposed FC-enhanced Inquiry-based teaching model template, which includes an explicit distribution of the generic teaching, learning and assessment activities within and beyond the physical learning space of the school classroom and/or lab.

Table 12.1 Flipped classroom inquiry-based model template

IBM Phase	"Home-based" activities	"School-based" activities
1. Orienting/ asking questions	**Teacher**: [Presents] using digital material (e.g., [**video**]) of the problem of the educational scenario to be researched.	**Teacher**: [Orchestrates Discussion] [**verbally**] on the problem to be researched
	[Presents] the educational objectives to be achieved and the [**Assignment(s)**] to be performed in Phase 4.	[Performs] [**diagnostic assessment**] quiz test.
	[Presents] the activities to be performed in the next f2f session.	These [**diagnostic assessment**] data will be utilised for scaffolding students with significant gaps in existing competences
	Students: [Study] the introductory digital material uploaded	**Students**: [Engage in Discussion] [**verbally**] based on their **prior** home study of the digital material
	[Engage in Discussion]/[Posts Questions] on the [**Forum**] to be discussed in the next f2f session	[Engage in task], i.e., the [**diagnostic assessment**] quiz.
2. Hypothesis generation & design	**Teacher**: [Presents] instructions to students to utilise [**concept map tool**] or [**Wiki**] tools to formulate *initial* hypotheses to answer the set problem.	**Teacher**: [Orchestrates Discussion] [**verbally**] on the problem to be researched
	[Monitors] student participation through [**LMS tracking data**] (e.g., resource views, page access traces, forum posts).	[Presents] information that might have escaped the students' notice.
	[Provides Feedback] when appropriate (e.g., [**Forum**]).	[Provides Feedback] when needed based on the [**LMS tracking data**] and observation.
	[Presents] the activities to be performed in the next f2f session	**Students**: [Engage in task], i.e., the formulation of *initial hypotheses* for the set problem (following the instructions) utilizing the given tools.
	[Assigns Task], i.e., to formulate *initial* hypotheses to answer the set problem (The task will continue in the next f2f session)	[Engage in Discussion] [**verbally**]
	Students: [Engage in task], i.e., familiarization with the tools for the formulation of *initial* hypotheses for the set problem, following the instructions	

(continued)

Table 12.1 (continued)

IBM Phase	"Home-based" activities	"School-based" activities
3. Analysis & interpretation	**Teacher**: [Shares Resources], i.e., digital research material (e.g., references, tools) related to the experimentation process of Phase 4.	**Teacher**: [Orchestrates Discussion] [**verbally**] on the digital research material and the experimentation process of Phase 4.
	[***Optionally***] Facilitates [Formulation of student groups], considering [**diagnostic assessment**] quiz results and [**LMS tracking data**].	[Provides Feedback] based on observation, Phase 1 [**diagnostic quiz assessment**] and [**LMS tracking data**].
	[Monitors] student participation through [**LMS tracking data**].	[Assigns Task], i.e., to locate further digital research material.
	[Provides Feedback] when appropriate (e.g., [**Forum**]).	**Students**: [Engage in task] of locating further digital research material.
	[Presents] the activities to be performed in the next f2f session.	[Engage in Discussion] [**verbally**] towards clear understanding of the Phase 4 experimentation process
	Students: [Enrol in Groups]	
	[Study] the digital research material uploaded	
	[Engage in Discussion]/[Posts Questions] on the [**Forum**] to be discussed in the next f2f session	
4. Planning & investigation	**Teacher**: [Shares Resources], i.e., digital resources for (a) explaining and (b) facilitating the experimentation process (e.g., [**virtual/remote lab**]).	**Teacher**: [Assigns Task], i.e., to perform experimentation process using the given digital resources
	[Monitors] student participation through [**LMS tracking data**].	[Provides Feedback] [**verbally**] during the experimentation process based on observation.
	[Provides Feedback] when appropriate towards ensuring all students' understanding on the Phase 4 experimentation process. ([**Forum**]).	**Students**: [Engage in task], i.e., in the experimentation process using the provided digital resources and/or [**physical tools**]
	[Presents] the activities of the next f2f session.	[Collect data] and [Record findings] from experiments towards answering the set problem
	Students: [Study] the digital research material uploaded	[Engage in task], i.e., formulation of the Assignment deliverable based on the experiment findings.
	[Engage in Discussion]/[Posts Questions] on the [**Forum**] to be discussed in the next f2f session	

(continued)

Table 12.1 (continued)

IBM Phase	"Home-based" activities	"School-based" activities
5. Conclusion & evaluation	**Teacher**: [Monitors] student participation through [**LMS tracking data**].	**Teacher**: [Assigns Task], i.e., to present their Assignment deliverables towards peer-assessment.
	[Provides Feedback] when appropriate (e.g., [**Forum**]).	[Provides Feedback] based on (a) students' [**Assignment**] deliverables, (b) [**LMS tracking data**] and (c) their presentations.
	[Shares Resources], i.e., peer-assessment rubric to be used for peer-assessment activity in next f2f session	**Students**: [Engage in task], i.e., presentation/peer-assessment of their Assignment deliverables.
	[Assesses] the students' [**digital deliverables**] and provides [**summative assessment**] feedback individually/in groups.	[Engage in Discussion] [**verbally**] towards receiving feedback based on the three aspects mentioned above and formulating a shared understanding of the experiment-based solution to the problem.
	[Presents] the activities of the next f2f session.	
	Students: [Submit deliverable], i.e., the final Assignment deliverables	
	[Reflect] on their final Assignment deliverables considering their *initial* hypotheses (Phase 2) and the [**summative assessment**] feedback.	

As the Table 12.1 depicts, the proposed FC-enhanced IBM template comprises sets of "generic" teaching/learning activity types which can provide a roadmap for teachers to populate and adapt to their own teaching needs and preferences. Furthermore, the template also provides a distribution of the aforementioned activities within and beyond the school physical premises towards facilitating the teacher to orchestrate the delivery of the lesson/educational scenario.

The following section presents another widely exploited teaching model in the context of STEM`, namely the Problem-based teaching model (PBM), and introduces the relevant proposed FC-enhanced template.

Problem-Based Flipped Classroom Teaching Model Template

The Problem-based (PB) approach is similar to the aforementioned IB approach, in the sense that it also requires the students to engage in research and inquiry processes towards solving an ill-defined problem (Hmelo-Silver & Eberbach, 2012).

More specifically, the main focal point and objective of the PB approach is to allow the students to identify, model, analyze and, ultimately, provide a solution for an ill-defined problem (Savery, 2015).

Based on these, the PB approach has been increasingly explored and investigated in the context of STEM education. Research works indicate that it has the potential to not only cultivate students' (collaborative) problem-solving skills (Klegeris & Hurren, 2011; Sayary et al., 2015), but also enhance their level of attainment of educational objectives (Wirkala & Kuhn, 2011; Yadav, Subedi, Lundeberg, & Bunting, 2011) and increase their level of motivation (Delialioglu, 2012; Wynn Sr, Mosholder, & Larsen, 2014). Therefore, the PB approach (and the relevant teaching model—PBM) is considered as an appropriate approach for supporting the emerging needs of STEM education, and thus, was used for formulating a FC-enhanced template.

The structural representation of the PB teaching model adopted in this chapter was proposed by Eggen and Kauchak (2011). Similarly to the IBM, it comprises five Phases, which are presented as follows:

- *Phase 1: Problem Identification*. Phase 1 involves the identification of the ill-defined problem to be solved.
- *Phase 2: Problem Representation*. Phase 2 involves the specific representation and modeling of the identified ill-defined problem (e.g., method of decomposition to its constituent parts).
- *Phase 3: Problem Solving Strategy Formulation/Selection*. Phase 3 is related to the selection or formulation of the optimal strategy for solving the identified ill-defined problem.
- *Phase 4: Problem Solving Strategy Implementation*. Phase 4 engages students in the process of implementing the selected strategy for solving the identified ill-defined problem.
- *Phase 5: Evaluation*. Phase 5 includes reflective analysis of the students' solutions to the identified ill-defined problem, based on the teacher's and peers' feedback.

Building on the aforementioned structural phases of the PBM, Table 12.2 presents the proposed FC-enhanced Problem-based teaching model template.

As the Table 12.2 depicts, the proposed PBM template adopts a similar approach to the previously described IBM template. More specifically, it provides a blueprint for STEM teachers to design their lessons and/or educational scenarios using "generic" educational activity types for each PBM Phase, as well as distributing these activity types within and beyond the school physical premises. Similarly to the IBM, the teacher-supported face-to-face activities have been populated with activity types linked to the core problem-solving processes of the PBM, e.g., the selection/formulation of the problem solving strategy to be exploited and its actual implementation. The student-led "home-based" activity types, on the other hand, mainly comprise engagement with learning material.

Overall, the proposed FC-enhanced teaching model templates aim at providing STEM teachers with "generic" frameworks which can be further adapted and

Table 12.2 Flipped classroom problem-based model template

PBM phase	"Home-based" activities	Face-to-face "School-based" activities
1. Problem identification	**Teacher**: [Presents] the problem of the educational scenario to be solved using digital material (e.g., [**video**]),	**Teacher**: [Orchestrates Discussion] [**verbally**] on the problem to be solved
	[Presents] the educational objectives to be achieved and provides the [**Assignment(s)**] to be performed.	[Performs] [**diagnostic assessment**] quiz test. These [**diagnostic assessment**] data will be utilised for scaffolding students with significant gaps in existing competences
	[Presents] the activities to be performed in the next f2f session.	**Students**: [Engage in Discussion] [**verbally**] based on their prior home study of the digital material
	Students: [Study] the introductory digital material uploaded	[Engage] in the [**diagnostic assessment**] quiz.
	[Engage in Discussion]/ [Posts Questions] on the [**Forum**] to be discussed in the next f2f session	
2. Problem representation	**Teacher**: [Shares Resources], i.e., digital support resources (e.g., tools and/or techniques) for modeling the problem.	**Teacher**: [Orchestrates Discussion] [**verbally**] on the problem to be solved and the digital support resources.
	[Monitors] student participation through [**LMS tracking data**].	[Presents] information that might have escaped the students' notice.
	[***Optionally***] [Formulates student groups], considering [**diagnostic assessment**] quiz results and [**LMS tracking data**].	[Assigns Task], i.e., to engage in problem modeling.
	[Provides Feedback] when appropriate (e.g., [**Forum**]).	[Provides Feedback] when needed based on the [**LMS tracking data**] and observation.
	[Presents] the activities to be performed in the next f2f session	**Students**: [Engage in task], i.e., model the problem using the methods/techniques provided in the digital support resources
	Students: [Study] the digital support resources	[Engage in Discussion] [**verbally**]
	[Engage in Discussion]/ [Posts Questions] on the [**Forum**] to be discussed in the next f2f session.	

(continued)

Table 12.2 (continued)

PBM phase	"Home-based" activities	Face-to-face "School-based" activities
3. Problem solving strategy formulation/selection	**Teacher**: [Shares Resources], i.e., digital support material (e.g., reports, tools) related to the candidate problem solving strategies.	**Teacher**: [Orchestrates discussion] [**verbally**] on the digital support material on the candidate problem solving strategies
	[Monitors] student participation through [**LMS tracking data**].	[Assigns Task], i.e., engages students to select/formulate the problem solving strategy to solve the problem.
	[Provides Feedback] when appropriate (e.g., [**Forum**]).	[Provides Feedback] when needed based on the [**LMS tracking data**] and observation.
	[Presents] the activities to be performed in the next f2f session.	**Students**: [Engage in Discussion] [**verbally**] towards clear understanding of the candidate problem solving strategies
	Students: [Study] the digital support material towards understanding the candidate problem solving strategies	[Engage in task] of selecting/ formulating the problem solving strategy to solve the problem.
	[Engages in Discussion]/ [Posts Questions] on the [**Forum**]	
4. Problem solving strategy implementation	**Teacher**: [Provides Feedback] when appropriate (e.g., [**Forum**]).	**Teacher**: [Assigns Task], i.e., to engage in the problem solving strategy implementation.
	[Presents] the activities to be performed in the next f2f session.	[Supports/Facilitates] students during the problem solving strategy implementation
	Students: [Engages in Discussion]/[Posts Questions] on the [**Forum**] towards full comprehension of the selected problem solving strategy and the way it will be used for solving the problem.	[Provides Feedback] [**verbally**] based on observation.
		Students: [Engage in task], i.e., in the problem solving strategy implementation.
		[Record findings] based on their problem solving strategy implementation towards solving the problem

(continued)

Table 12.2 (continued)

PBM phase	"Home-based" activities	Face-to-face "School-based" activities
5. Evaluation	**Teacher**: [Monitors] student participation through [**LMS tracking data**].	**Teacher**: [Assigns Task], i.e., to present their Assignment deliverables towards peer-assessment.
	[Provides Feedback] when appropriate (e.g., [**Forum**]).	[Provides Feedback] based on (a) students' [**Assignment**] deliverables, (b) [**LMS tracking data**] and (c) their presentations.
	[Shares Resources], i.e., peer-assessment rubric to be used for peer-assessment activity in next f2f session	**Students**: [Engage in task], i.e., in Presentations/peer-assessment of their Assignment deliverables.
	[Assesses] the students' [**digital deliverables**] and provides [**summative assessment**] feedback individually/in groups.	[Engage in Discussion] [**verbally**] towards receiving feedback based on the three aspects mentioned above and formulating a shared understanding of the solution to the problem.
	[Presents] the activities of the next f2f session.	
	Students: [Submit deliverable] i.e., the final Assignment deliverables.	
	[Reflect] on their final Assignment deliverables considering the [**summative assessment**] feedback.	

instantiated with specific educational activities and educational resources/tools towards meeting their own teaching needs. Building on the aforementioned FC-enhanced teaching model templates, which focus on facilitating novice STEM teachers to design their FC-enhanced lessons and/or educational scenarios, the following section addresses the aspect of delivering the latter to students, by presenting the Moodle-based implementations of the aforementioned teaching model templates.

Implementation of the Flipped Classroom Teaching Model Templates in Moodle LMS

This section will present the implementation of the proposed IBM and PBM templates in the Moodle Learning Management System (LMS). Moodle is an open source LMS which is commonly and widely used by teachers in order to host and deliver blended (and online) learning interventions (Cole & Foster, 2008).

In the context of this chapter, the default installation of the Moodle LMS (version 2.9.1) was selected for implementing the IBM and PBM templates due to the facts that (a) it is available free of charge, (b) it has created and is supported by a vast community of teacher practitioners[2] and (c) offers a very wide range of functionalities and affordances, which are comparable to commercial LMS (Lewis et al., 2005). Therefore, it presents a promising solution for teachers to exploit in order to design and deliver their blended (and online) learning interventions.

The process of implementing the teaching model templates in Moodle, towards selecting the most appropriate tools for each teaching/learning activity type, an affordance-based approach was adopted. More specifically, each Moodle tool was evaluated and selected in terms of the basic affordances it had. For this evaluation process, a classification of basic technology affordance types was utilised. The basic technology affordance types used to classify the Moodle tools are based on the works of McLoughlin and Lee (2007), Logan and Neumann (2010) and LTI (2011). These basic technology affordance (BTA) types are not mutually exclusive (i.e., a tool can afford more than one type). The adopted classification schema comprises four types, as follows:

- *[BTA_1]—Access to Information and Content*. This affordance relates to the capacity of the tool to disseminate content from the teacher. Tools that have this affordance can be used for delivering important information and/or learning material to the students.
- *[BTA_2]—Assessment of Learning*. This affordance relates to the capacity of the tool to be utilised for assessment purposes. Tools that have this affordance can be used for providing automatic assessment capabilities (e.g., automatically assessed quizzes) or provide the means for students to deliver their assignments.
- *[BTA_3]—Communication and Collaboration*. This affordance relates to the capacity of the tool to foster communication and collaboration between the teacher and the students and/or between the students. Tools that have this affordance can be used for managing collaborative activities or simply for establishing communications channel.
- *[BTA_4]—Creation of Content*. This affordance relates to the capacity of the tool to be utilised by students in order to formulate their own content and deliverables. Tools that have this affordance can be used for facilitating artifact creation.

The aforementioned schema was utilised in this chapter in order to evaluate the affordance-based appropriateness of each Moodle tool to support the needs of the corresponding learning/teaching activity type. The following sections present the design and the implementation of the Moodle instantiations of the two teaching model templates.

[2] Retrieved June 5, 2016, from https://moodle.net/stats/.

Inquiry-Based Flipped Classroom Teaching Model Template in Moodle

Table 12.3 depicts the Moodle tools utilised for the inquiry-based FC model template. For each of the tools, a brief description is provided, along with its core affordances in relation to the teaching/learning activity type(s) it aimed to support. Moreover, tools that were recurrently used for the same purpose, are only described once (i.e., "Cross-Phase" tools in Table 12.3). Regarding the teaching/learning activities occurring in the face-to-face sessions, only those that require the support of Moodle have been included in the Table 12.3 (e.g., live discussions between the teacher and students are not documented).

As the Table 12.3 depicts, each of the Moodle tool was selected on an affordance-based manner towards meeting the needs of the teaching/learning activity type it was assigned to. Furthermore, the distribution of Moodle tools for each teaching/learning activity type reflects the standpoints of the FC model, i.e., the "home-based" activities are mainly supported by Moodle tools possessing affordances related to "Access to Information and Content" and to a lesser extent to "Communication and Collaboration" (for the provision of feedback). On the other hand, "school-based" activity types are mainly supported by Moodle tools that afford "Assessment of Learning", "Communication and Collaboration" and "Creation of Content". This was based on the notion that face-to-face sessions should be exploited in order to promote active engagement and collaboration from the students.

Figures 12.1 and 12.2 depict excerpts from the Moodle-based implementation of the FC-enhanced IBM template. The excerpts, which are presented for exhibiting exemplary sections of the implementations, present the initial Introduction section of the template and the flow of teaching/learning activities, respectively.

More specifically, Fig. 12.2 demonstrates the clear distribution of the teaching/learning activities between "home-based" and "school-based", as well as the division of the template in the corresponding Inquiry Phases. Additionally, as the excerpt from the Fig. 12.2 depicts, teachers are provided with blueprint selections of Moodle tools (e.g., the "Quiz" tool for the "school-based" diagnostic assessment of students) in order to be able to populate and instantiate them according to their own needs and preferences (the full selection of Moodle tools was described in Table 12.3).

The following section presents the Moodle implementation of the Problem-based Flipped Classroom template.

Problem-Based Flipped Classroom Teaching Model Template in Moodle

Table 12.4 depicts the Moodle tools utilised for the FC-enhanced Problem-based template. The FC-enhanced Problem-based template incorporates the same set of "Cross-Phase" Moodle tools to the FC-enhanced IBM model, therefore, these have not been included in Table 12.4.

Table 12.3 Moodle tools selected to implement IB FC model template

IB phase	Activity type[a]	Moodle tool	Description	Affordances
Cross-phase	**Teacher** [**MB**]: Presentation of upcoming face-to-face activities	News Forum	The "News Forum" tool allows the teacher to disseminate important announcements to the learners. Usually, learners are not allowed to post in this Forum.	[BTA_1]
	Teacher [**MB**]: Monitor Student Participation	Moodle student tracking data	Moodle incorporates a number of built-in student tracking data, e.g., activity completion by students, which can be used by the teacher to track their students' activities	[BTA_2]
	Teacher [**MB**]: Provide Feedback	Forum	The "Forum" tool enables teachers and learners to create threads and sharing content. Contrary to the "News Forum", it is editable by students' discussions. A "Q&A" instance of the Forum can be created to allow for a space of feedback provision.	[BTA_1], [BTA_3]
	Students [**MB**]: Engage in Discussion/Post Questions	Forum	Instances of the "Forum" tool can be created to foster discussions among students	[BTA_1], [BTA_3]
	Teacher [**MB/SB**]: Task Assignment	Checklist	The "Checklist" tool allows a teacher to create a task list to guide their students through a series of to-do items	[BTA_1]
	Teacher [**MB/SB**]: Grading Students Process	Gradebook	This "Gradebook" tool enables teachers to have an automatically created grades' record per learner from all assessment activities	[BTA_2]

(continued)

Table 12.3 (continued)

IB phase	Activity type[a]	Moodle tool	Description	Affordances
Orienting/ Asking Questions	**Teacher** [**MB**]: Presentation of the educational objectives, the assignment and digital material for the research problem	Page	The "Page" tool allows teachers to formulate and share a page containing educational material or information. Furthermore, the embeddable content types include a wide range of file types	[BTA_1]
	Teacher/**Student** [**SB**]: Deliver diagnostic assessment quiz	Quiz	The "Quiz" tool allows teachers to create quizzes of various types (e.g., MCQ). Time limits, automatic feedback and grading and connection to the overall Moodle Gradebook are supported	[BTA_2]
Hypothesis Generation & design	**Teacher**/**Student** [**MB**]: Instructions for Hypothesis Formulation	Wiki	The "Wiki" tool affords collaborative or individual creation of content by the teachers and the learners. [At this stage, the wiki can be used for providing instructions to use and the students will familiarise themselves with the tool]	[BTA_1], [BTA_3]
	Teacher [**MB**]: Provision of feedback (selective)	File with Restricted Access	The "File" tool can be utilised in order to facilitate the teacher to provide specific students (based on the diagnostic assessment results) with additional educational material	[BTA_1]
	Student [**SB**]: Hypotheses Formulation	Wiki	[At this stage, the full potential of the "Wiki" tool is exploited, by allowing students to actively create their initial hypotheses]	[BTA_1], [BTA_2], [BTA_3], [BTA_4]

(continued)

Table 12.3 (continued)

IB phase	Activity type[a]	Moodle tool	Description	Affordances
Analysis and interpretation	**Teacher** [**MB**]: [Shares Resources]—Digital Research Material	File/Folder	The "File"/"Folder" tools enable teachers to display content to the students. The latter adds the functionality to group many related files in a single folder	[BTA_1]
	Teacher/Student [**MB**]: Student Group Formulation	Group Choice	The "Group Choice" tool enables learners to enrol themselves in an existing group. Furthermore, it allows the teacher to alter these groups based on their own opinion	[BTA_3]
	Student [**SB**]: Engage in task—Locating and collect digital research material	Database	The "Database" tool allows for (individually or collaboratively) creating, storing and searching for any kind of digital content. Grading, commenting and time restrictions are supported.	[BTA_2], [BTA_3], [BTA_4]
Planning & investigation	**Teacher** [**MB**]: [Shares Resources]—Digital resources	File/Folder Page	The "File"/"Folder" tools enable teachers to display file to the students. The latter adds the functionality to group many related files in a single folder. In case of digital tools, a "Page" tool can be used to provide the URLs and description of the digital tools	[BTA_1]
	Student [**SB**]: Engage in task—Collect data from experiments	Database/ Wiki	Either the "Database" or the "Wiki" tool can be used at this stage, to facilitate the students to store and organise their collected data	[BTA_2], [BTA_3], [BTA_4]
Conclusion & evaluation	**Teacher** [**MB**]: Share Resources: Peer-Assessment Rubric	Workshop	The "Workshop" tool enables the collection, review and (peer) assessment of the learners' deliverables. The latter can be achieved through rubrics provided by the teacher. It supports any kind of digital file and incorporates deadline and grading functionalities.	[BTA_1], [BTA_2]
	Student [**MB**]: Submit deliverable			

[a][MB] = Moodle-based activity, [SB] = School-based activity

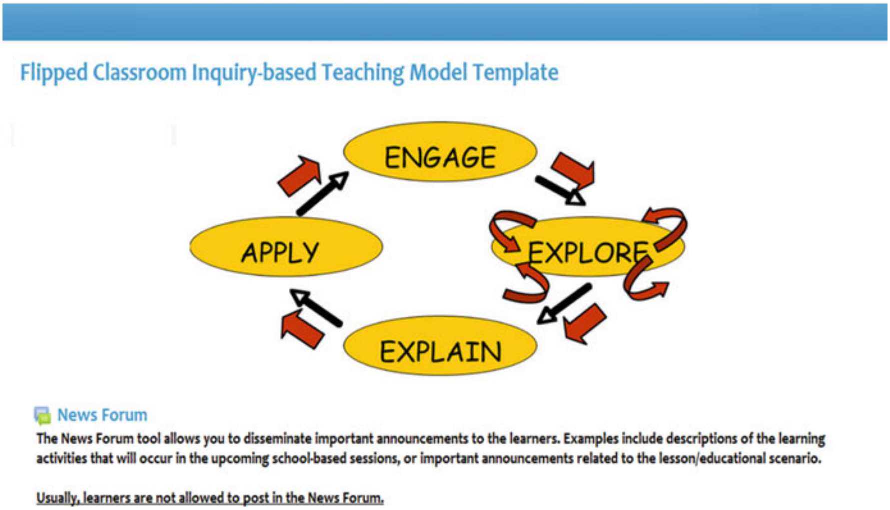

Fig. 12.1 Excerpt from the FC-enhanced IBL Moodle-based template (Introduction section)

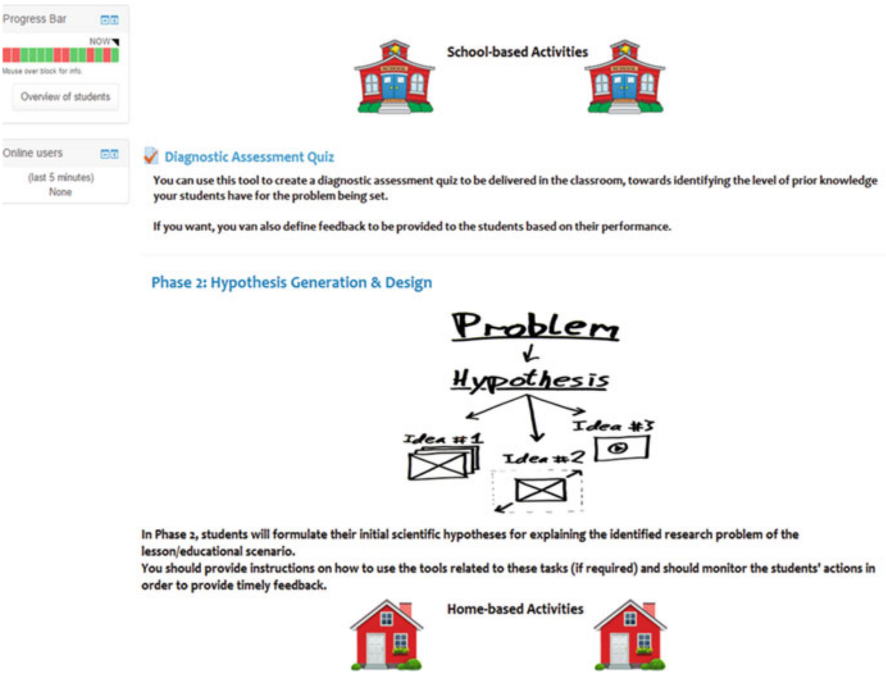

Fig. 12.2 Excerpt from the FC-enhanced IBL Moodle-based template (flow of activities)

Table 12.4 Moodle tools selected to implement PB FC model template

PB phase	Activity type[a]	Moodle tool	Description	Affordances
Problem identification	**Teacher** [**MB**]: Presentation of the educational objectives, the assignment and digital material for the research problem	Page	The "Page" tool allows teachers to formulate and share a page containing the required educational material for this Phase	[BTA_1]
	Teacher/Student [**SB**]: Deliver diagnostic assessment quiz	Quiz or Wiki	The "Quiz" activity should exploit quiz types allowing students to depict their existing knowledge on the problem addressed. Alternatively, the "Wiki" tool can be employed to facilitate in the process of students' formulation of their responses (i.e., in case the latter are needed as free-text with embedded multimedia).	[BTA_2] [and/or BTA_4]
Problem representation	**Teacher** [**MB**]: **[**Shares Resources]—Support resources for modeling the problem	Page or Lesson	The "Page" tool can be used in order to directly provide resources to the students. Alternatively, the "Lesson" tool can allow more flexible way, i.e., own choices in terms of access flow	[BTA_1]
	Teacher [**MB**]: Provision of feedback (selective)	File with Restricted Access	The "File" tool can be utilised in order to provide specific students (based on the diagnostic assessment results) with additional educational material	[BTA_1]
	Teacher/Student [**MB**]: Student Group Formulation (Optional)	Group Choice	The "Group Choice" tool can be used for this activity type, similarly to the IBM template	[BTA_3]
	Student [**SB**]: Engage in task—Model problem	Wiki	The "Wiki" tool is exploited towards allowing students to model their problem and enhance their work with potential external resources	[BTA_1], [BTA_2], [BTA_3], [BTA_4]

(continued)

Table 12.4 (continued)

PB phase	Activity type[a]	Moodle tool	Description	Affordances
Problem solving strategy formulation/ selection	**Teacher** [**MB**]: **[**Shares Resources]—Support digital material for problem solving strategies	Page or Lesson	Similarly to the previous Phase, either the “Page” or the “Lesson” tools can be used, depending on the preferences of the teacher	[BTA_1]
	Student [**SB**]: Engage in task—Select Problem-solving strategy	Choice/Feedback	The “Choice” tool allows the teacher to create a poll with their students in order to reach consensus on a matter	[BTA_3]
			Alternatively, the “Feedback” tool can incorporate free-text elaboration of students on their answers	
Problem solving strategy implementation	**Student** [**SB**]: Engage in task—Perform Problem-solving strategy	Database/Wiki	Either the “Database” or the “Wiki” tool can be used at this stage, to facilitate the students to store and organise their collected data	[BTA_2], [BTA_3], [BTA_4]
Evaluation	**Teacher** [**MB**]: Share Resources: Peer-Assessment Rubric	Workshop/ Assignment	The “Workshop” tool can be used if peer-assessment is expected, using rubrics provided by the teacher. If peer-assessment is not required, the “Assignment” tool can be used for allowing students to upload their individual assignments	[BTA_1], [BTA_2]
	Student [**MB**]: Submit deliverable			

[a][MB] = Moodle-based activity, [SB] = School-based activity

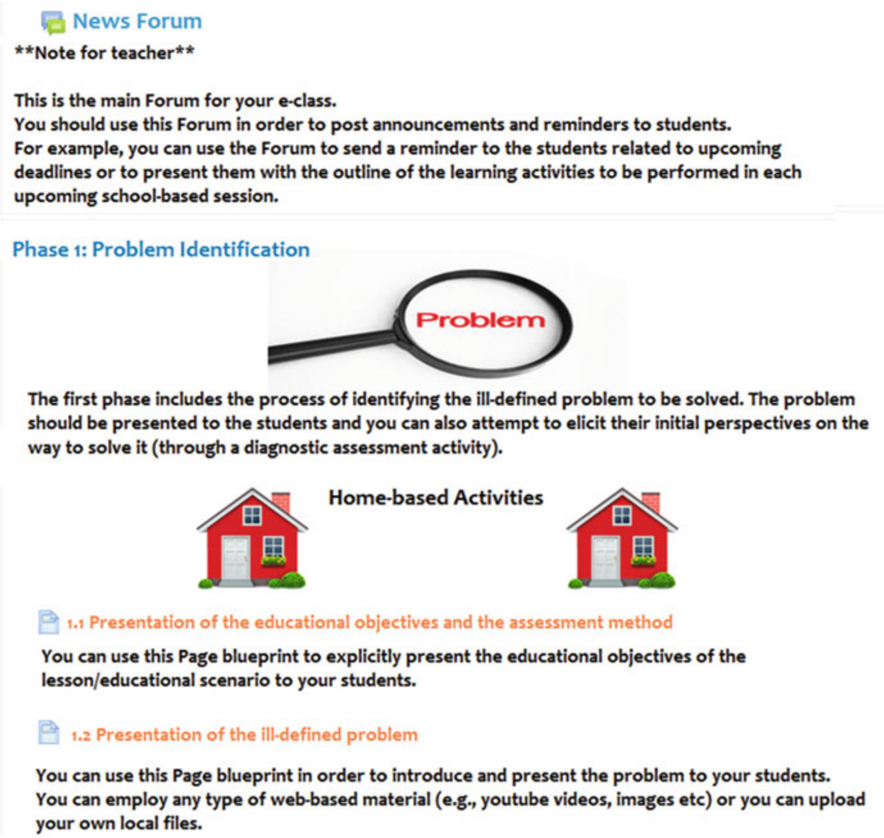

Fig. 12.3 Excerpt from the FC-enhanced PBL Moodle-based template (flow of activities)

Figure 12.3 depicts the distribution of the teaching/learning activities between “home-based” and “school-based”, as well as the division of the template in the corresponding Phases of the PBM. As the Fig. 12.3 demonstrates, teachers are provided with blueprint selections of Moodle tools in order to be able to directly edit them and instantiate their lesson/educational scenario towards delivering it to their students.

Overall, the Moodle-based implementations of the FC-enhanced IBM and PBM templates aim at capitalizing on the basic functionalities of the widely used Moodle LMS in order to offer a “generic” and adaptable framework for STEM teachers to exploit. More specifically, based on each teachers’ needs and preferences, the aforementioned templates can be either directly instantiated and delivered, or extended and altered, considering the high degree of flexibility and adaptability offered by the Moodle LMS in terms of externally embeddable tools and settings’ configurations.

In conjunction to the IBM and PBM design templates presented in section "Design of the Flipped Classroom Teaching Model Templates", the Moodle-based implementations aim to provide teachers with support towards exploiting the potential benefits of the FC model by streamlining part of the process of designing and developing their STEM lessons and/or educational scenarios.

Conclusions and Future Work

In the context of STEM education, existing student-centered teaching approaches (such as the Inquiry- and Problem-based approaches) are being extensively considered in order to actively foster students' competences related to conducting inquiry and engaging in problem-solving. Furthermore, emerging blended learning models, such as the Flipped Classroom model, are utilised in order to enhance the aforementioned teaching approaches towards optimal exploitation of the teaching time in face-to-face, teacher-supported sessions.

In this context, the chapter builds on prior work, and presents a set of teaching model templates that aim to facilitate novice STEM teachers to both design and deliver their FC-enhanced lessons and/or educational scenarios. More specifically, the chapter presents two "generic" design templates based on the IB and the PB teaching models, further enhanced by the standpoints of the FC model. These teaching model templates aim to support novice teachers when designing their lessons and/or educational scenarios, by depicting a blueprint of teaching/learning/assessment activity types, as well as their distribution within and beyond the physical school premises. Furthermore, these design templates are complemented with their Moodle-based implementations, in order to provide an additional layer of support to the STEM teachers, aiming at the delivery of their designed lessons and/or educational scenarios.

Future work strands could include (a) the formulation of additional Flipped Classroom templates focusing on teaching models identified as effective in other subject domains, such as the Social Sciences or Humanities Studies, and (b) the thorough evaluation of the proposed teaching model templates and their Moodle-based implementations from actual teachers in order to assess the level in which they offer significant added value towards authoring and delivering their Flipped Classroom lessons and/or educational scenarios.

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Chapter 13
Assessment of Online Learning

Michael J. Timms

Abstract One of the challenges for the teacher in an online learning situation is to maintain a sense of each learner's progress towards the instructional goals. In a face-to-face classroom the teacher can get a sense of when a learner is confused or going down the wrong path from simple observation of the body language of the learner or the actions that they are taking as they tackle assigned tasks. Online learning removes some of the channels of information that are available in a traditional classroom, so the teacher needs to rely more on channels like assessment of learning. In this chapter we explore what kinds of assessment are possible in an online learning environment and how might they be integrated into the instructional process so that teaching and learning are enriched.

Keywords Challenges • Teacher • Online learning environment • Learner • Instructional objectives • Face-to-face • Classroom environment • Simple observations • Student • Body language • Communication • Online learning • Classroom • Assessment • Instructional process • Teaching and learning

Introduction

One of the challenges for the teacher in an online learning situation is to maintain a sense of each learner's progress towards the instructional goals. In a face-to-face classroom the teacher can get a sense of when a learner is confused or going down the wrong path from simple observation of the body language of the learner or the actions that they are taking as they tackle assigned tasks. Online learning removes some of the channels of information that are available in a traditional classroom, so the teacher needs to rely more on channels like assessment of learning. In this chapter we explore what kinds of assessment are possible in an online learning environment and how might they be integrated into the instructional process so that teaching and learning are enriched.

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Types of Online Assessment

Teachers and traditional classrooms may use a variety of assessment methods to obtain a picture of how well their students are progressing in their learning. Common types of assessment include selected response items in which a student makes a choice from responses that are suggested to them. For example, a common format is a four choice multiple-choice item in which there is one correct answer and three distracters. Other selected-response items include true/false and multiple-selection where students have to select which of the correct responses from a list where the solution includes two or more options. Other common assessments formats include asking a question of the student so that they had to provide a constructed-response. In other words no solutions are offered to the student and they must construct their own response. Often this involves the student writing a short or long text response, or showing a set of solution steps as in a mathematical response.

When teachers move to online learning they often, as a first step, simply move their selected-response and simple constructed response items into an online format. While this is a good place to start, it ignores the fact that digital environments offer a greater range of item types than traditional paper-and-pencil tests. Figure 13.1 shows a taxonomy of digital assessment formats that was developed by Kathy Scalise (2009) at the University of Oregon, USA. The taxonomy is organised in a grid with two axes, the vertical one showing a progression (top to bottom) from the less complex items to more complex items and the horizontal one showing a progression (left to right) from more constrained to less constrained. Readers are encouraged to visit the website that houses the taxonomy because many of the grid cells have a clickable example that demonstrates how each item type described behaves (http://pages.uoregon.edu/kscalise/taxonomy/taxonomy.html).

The term "constrained" here refers to how restricted the student is in how they can respond to the question. In the most constrained types of items like multiple-choice in the first column, the student can only select from predetermined choices. In the intermediate constraint items students have more scope, using tools provided in the assessment item to construct the response to the question. In the fully constructed item types like a project, the student has greater control over what is submitted in their response. Note that there are not examples in the final column because those types of items are not easy to represent in an example. This does not mean, however, that it is not possible to use those items in online learning.

In general, constrained types of items like multiple-choice are more limited in the types of knowledge and skill that they can assess. At worst, multiple-choice items may only ask questions that require students just to recall facts, like "When did the First World War take place?" rather than using less constrained items like a moderately constrained drag and drop item in which the student has to place a list of events leading up to the outbreak of the First World War into chronological order. This second item uses some of the technological advantage of digital items to elicit different response types. Moving further to right of the taxonomy an even less constrained task might be to have students type a response to the question, "Which of

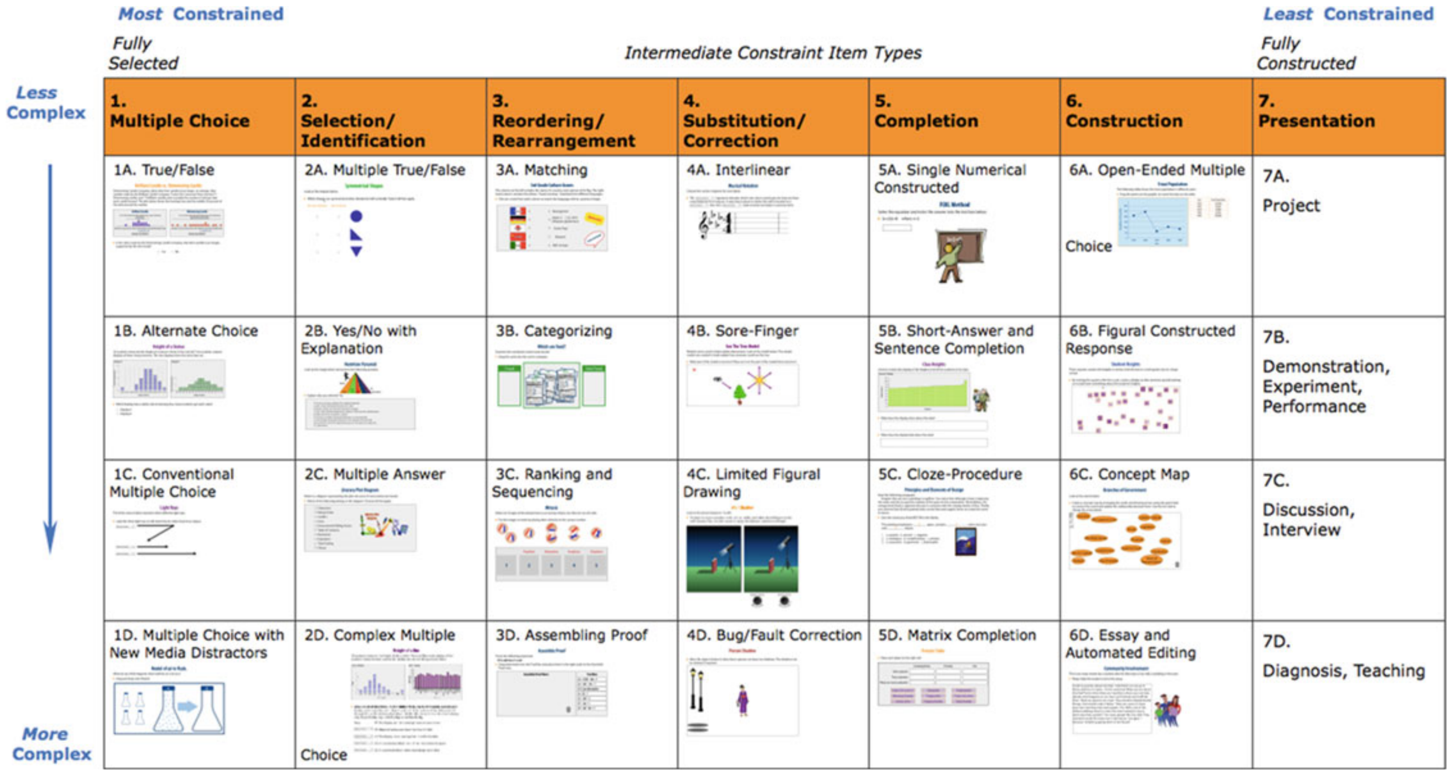

Fig. 13.1 Taxonomy of online assessment types (*Source*: Kathleen Scalise, University of Oregon, June 2009. http://pages.uoregon.edu/kscalise/taxonomy/taxonomy.html. Used with permission)

the events leading up to the outbreak of the First World War do you think contributed most to starting the War?" The important thing in developing assessments for online learning, as with classroom based learning, is to have a clear idea of what the learning goals are for students and to choose assessment types that are aligned to the learning goals, produce responses that you will consider as evidence that the learning goals have been achieved, and that the tasks which students have to perform in responding to the items are as authentic as possible applications of the knowledge and skills. If these criteria are met, you will probably find that you are developing or selecting assessment tasks that are spread across the taxonomy grid, rather than all being in the left hand columns.

One distinct advantage of moving to online selected-response types of assessment is that they lend themselves to automation of the scoring. This provides an advance over paper-based multiple-choice items because it relieves the teacher of the burden of scoring student responses manually. The system can provide scores for individual items and a total score overall.

There are many applications available on the Internet to create simple multiple-choice assessments and a search engine will return many results if you look. For more sophisticated development of complex questions a better choice is to work within a learning management system that offers an assessment feature. Two of the more popular Learning management systems, *Moodle* and *Blackboard* have ways of creating different assessment item types.

Moodle, for example, allows a number of different assessment types including single-answer questions that allow only one answer to be chosen by providing radio buttons next to the answers. It also allows teachers to set negative or non-negative marks for each answer, usually zero marks for wrong answers, maximum marks for correct answers and partial marks for partially correct answers. The next section in this chapter addresses the issues around scoring and analysing responses.

Scoring and Analysing Responses

In the kinds of large-scale assessments that are used by education systems like governments and states to judge the levels of achievement of students across the education system a lot of expertise goes into scoring and analysing the results. Such assessments do not use just percent correct as the measure of student performance. They use methods that judge student performance by taking account of not only how many items a student got right, but also the relative difficulty of those items they were able to answer correctly. A whole field of psychometrics has grown up around this kind of assessment and sophisticated statistical methods are used to ensure that the assessments are reliable and valid. The level of resources needed to acquire this level of reliability and validity is considerable and is not practicable for classroom assessments or, by extension, online assessments that are designed by teachers.

Learning management systems now offer opportunities for teachers to include features in their assessment items that were not available when they were designing traditional paper-and-pencil tests. In general, this is a good thing but there are issues that educators should be aware of when using such systems to design their own assessments. This section addresses some of those features and explains why teachers need to use some of them with caution.

Item Difficulty

Item difficulty is a measure of how hard a question is for students to answer. In selected response type items it is often reported as the percentage of students who got the question correct but there are more sophisticated measures that take account of the difficulty of the item in relation to other questions in the same assessment. There are also ways to measure the difficulty of an item that is scored using a scoring guide or rubric with several levels, expressing the difficulty of getting a score at each level of the item. Item difficulty is a function of the interaction of the students and the items and it can be affected not only by the inherent difficulty of the topic being assessed but also by other features of the item such as the reading level required to understand the question being asked. Even familiarity with the type of item can affect the difficulty, which can be a factor in the digital environment that allows a broader range of item types, some of which might be new to students.

Difficulty of questions can vary when you change the features of a question. One feature that is offered in some assessment item authoring is the ability to create "unique" questions for every student by randomly selecting values that are inserted into an "item shell". For example, in *Blackboard*, one option is the "Calculated Formula" questions in which students make a calculation and respond by entering a numeric answer. The feature allows for the numbers in the question to change for each student and when the question is presented to a learner, values are drawn from a range of values that the teacher has set. To use an example from the Blackboard help site, a question shell might be

If a small glass can hold [x] ounces of water, and a large glass can hold [y] ounces of water, what is the total number of ounces in 4 large and 3 small glasses of water?

When the item is administered to a student the variables [x] and [y] are replaced with values that are generated randomly from the specified range. So if the values selected were 6 and 9, then the question would be shown as in Fig. 13.2.

The advantage of this feature is that each student gets a question with a randomly selected set of values so that cheating cannot occur among students since they are less likely to have the exact same question, yet the general nature of the question remains the same. The problem with this is that from an educational measurement point of view, the difficulty of solving the question when the values of [x] and [y] are 9 and 6 could be more or less difficult than if the numbers are 12 and 9. And yet, as

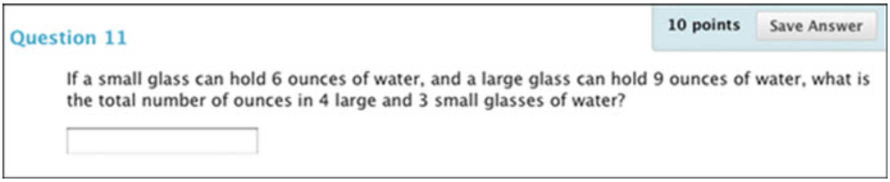

Fig. 13.2 Example of a question ccreated using the "Calculated Formula" question feature in *Blackboard*

can be seen in Fig. 13.2, a student is awarded 10 points for a correct response, regardless of how difficult the question is. If the assessment is being used to assess progress and give feedback to the learner, this is not problematic, but if a final grade is being based on a series of questions like this, it might be unfair to some students.

Partial Credit

Partial credit scoring of an item response refers to scoring schemes in which a correct response might get all the available points for an item but that there are points awarded for incomplete or partially correct responses as well. This kind of scoring is commonly applied in tasks where there are multiple steps for a student to complete because it allows for a more subtle scoring that recognises that some students may have acquired some, but not all, of the required skills to complete the question fully and correctly. It is advantageous to recognise the partial knowledge and skills that students have, but there are also cautions that need to be heeded.

Some of the features in learning management systems question authoring systems allow awarding partial credit. However, the challenge comes in deciding what score to assign to partial answers because, without pilot testing an assessment and conducting statistical analyses to determine the measurement properties it is not possible to accurately model what the value should be. For example, a teacher should bear in mind that by giving, say a quarter of the total points for a partial answer to an item, this is saying that a correct answer shows four times more learning of that skill. This may be an exaggeration of the difference in performance. A good rule of thumb is to use partial credit where it is appropriate to reward partial knowledge or skill but to make sure that the differential between the score levels is reflective of the learning and not overly weighted.

Penalty Factors

Some assessment authoring systems allow the use of a "penalty factor" that can be used when a student is allowed multiple attempts at a question. The idea of this feature is that if a student takes more than one try to select a correct response, each subsequent try should be worth fewer points towards a total score. For example, if a question carries 10 points for a correct response, and the penalty factor is set to 0.2, then each successive attempt after the first one will incur a penalty of $0.2 \times 10 = 2$ points. Again, while this has some practical use if the assessment is being used to provide feedback in learning, it might have unintended consequences if it forms part of an overall score for a final grade. The reason is that, without collecting educational measurement information, we simply don't know if getting the right answer on the second try really is only equivalent to 8 points, or if it should be more or less. Again, use this kind of feature with caution and not for high stakes judgment.

Continuous Assessment

One of the criticisms of traditional teaching is that assessment is often an interruption to the "learning"—that is that it is not embedded in the learning task, but often an add-on. This leads to a model of the teaching and assessment sequence like that shown in Fig. 13.3. In this first model instruction occurs then stops for an assessment of learning and continues afterwards with another teaching session and so forth.

In this traditional model, the results of the assessment may be used to modify teaching in the next segment of instruction, but this is not commonly done. The curriculum typically demands coverage of a wide breadth of content and teachers often feel that there is not time to stop and act on the results of the assessment. A model that is more focused on obtaining results from assessment tasks to provide feedback to both the student and the teacher is shown in the second model in Fig. 13.4.

Fig. 13.3 Model of the teaching and assessment sequence in a traditional classroom

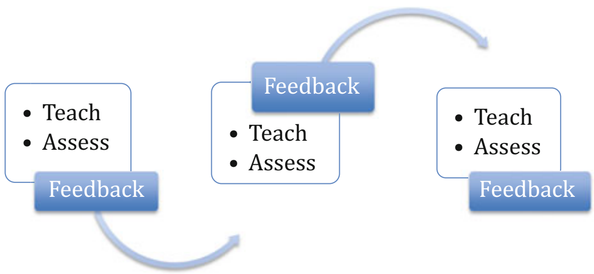

Fig. 13.4 Model of the teaching and assessment sequence in a classroom with continuous assessment

In this model the assessment is embedded in the learning task so that the learner is continuously assessed. This model allows for real time feedback to the learner so that she knows how she is progressing and what to do next. It also is designed to give summary feedback to the teacher so that he or she can modify and differentiate instruction to better support students who are struggling with the material. Digital learning environments offer opportunities to support the second model of assessment and online learning can be patterned in this manner. The next section of this chapter looks at some examples of how online learning environments have followed this model.

Assessment of Skills

As discussed earlier, often what we are trying to promote in students is the acquisition of skills rather than just filling their heads with a series of facts. That is not to say that knowing facts is not important, but if that is all that is assessed then an inaccurate measurement of learners can occur. Students who find it easier to remember and recall facts will do well on questions that demand only that, but they may not actually have grasped the skills in which those facts are applied. To see if students can apply these skills, new formats of online items have been developed that involve scenarios and/or simulations in which students can show their skills and the higher order thinking that is involved in the application of those skills.

Science is an area in which the inquiry practices of the discipline are important skills for students to develop and so there has been a lot of development of interactive learning environments with embedded assessment items in this field. Interactive Learning Environments (ILEs) are designed to combine pedagogical approaches that are based on cognitive theory of learning with methods of measuring the progress of learners and techniques for providing assistance at key moments.

In science students often have difficulty connecting concepts to real world phenomena and in understanding how to use scientific practices in investigating those phenomena (Martin et al., 2008). Studies in the USA point to the lack of "rigorous and excellent" instruction in US schools on science inquiry skills—those that build student ability to form ideas or hypotheses about phenomena and to design experiments to test those ideas (Weiss & Pasley, 2004).

An example of how learning activities and interactive assessments can be blended to form an Intelligent Learning Environment is the *SimScientists* project (www.simscientists.org). The *SimScientists* suite of modules uses simulations to enrich science learning and assessment for students in middle school and secondary school. The science simulations are used in curriculum activities as embedded, formative assessments, and as summative assessments (Quellmalz et al., 2010).

The simulations in *SimScientists* modules present students with rich task environments that model key features of science systems in action in the natural world. They cover topics in Life Science (Ecosystems and Cells & Human Body Systems), Physical Science (Forces & Motion and Atoms & Molecules), and Earth Science

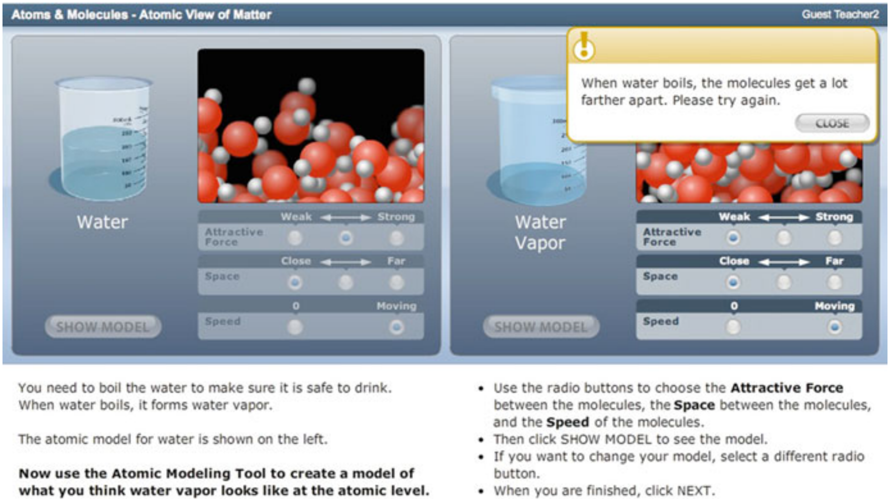

Fig. 13.5 Screenshot from the *SimScientists* module on atoms and molecules

(Climate and Plate Tectonics). A screenshot from the Atoms & Molecules module is shown in Fig. 13.5.

The reason for using simulations in science is that they present authentic environments structured according to principles in the domain. The advantage of this digital approach is that spatial, temporal, and causal phenomena can be represented that may be otherwise unobservable and not directly manipulable because they are too large (hurricanes), or too small (chemical reactions), too fast (earthquakes), or too slow (plant growth). Simulations also have the advantage of being able to present content in multiple representational forms, which has been shown in numerous studies to help students to build mental models of concepts and principles (e.g. Buckley, Gobert, Horwitz, & O'Dwyer, 2010; Hmelo-Silver et al., 2008; Ioannidou et al., 2010; Slotta & Chi, 2006). In addition to having advantages for student learning, simulations offer advantages for assessment too. They offer the opportunity to design assessments of systems thinking, model based reasoning, and scientific inquiry that are seldom tapped in static, conventional tests (Quellmalz, Timms, Silberglitt, & Buckley, 2012). In other words, simulations offer opportunities to examine the learning process in addition to learning outcomes.

In the *SimScientists* online modules, as students interact with the simulations, the system tracks their responses and provides feedback in the form of indicating correct/incorrect actions, drawing attention to types of errors and through delivering a sequence of increasingly helpful hints that indicate what the student should do next. As an example, Fig. 13.5 shows a task from the Atoms & Molecules module in which the student has to use an "Atomic Modelling Tool" that allows the learner to create a model of what he/she thinks water vapour would look like at the atomic level.

The *SimScientists* projects use Contingent Based Modeling (CBM) in which the systems are designed to detect when students are making errors or behaving in ways that are known to be unproductive. When these contingent behaviours are detected, the system is designed to flag the error and offer a sequence of hints that lead the student to a productive solution. In the screenshot shown in Fig. 13.5, the student has received a medium level hint which says that "When water boils the molecules get a lot further apart. Please try again."

In this way, the student is supported as they go forward. A "bottom-out" hint provides the student with all the information they need to correct an error and move on, so students do not get stuck.

The scoring system keeps a record of what levels of help a student needed with each task and the learning goal for each task. This enables a report to be produced at the end of a module for the student that summarises what areas of the knowledge and skills they still need to work on. Importantly, and applicable for online learning situations, the system also provides a summary report for teachers which shows collectively for the class, which topics they are still struggling with. In the *SimScientists* modules, it even recommends how teachers can group students who still need additional instruction into small groups to work collectively on building the missing skills. The *SimScientists* modules were field-tested in three US states to test the feasibility and utility of this approach. The study showed that the assessments demonstrated the high psychometric quality (reliability and validity) and that they were able to effectively assess content knowledge and science inquiry practices.

Another example of this embedded assessment approach in an online system is *ChemVlab+* (www.chemvlab.org), an interactive learning environment in which secondary (high school) students work with a virtual chemistry laboratory to undertake tasks in a series of embedded assessment modules that provide them with opportunities to apply chemistry knowledge in meaningful contexts and to receive immediate, individualised tutoring (Davenport, & Quellmalz accepted; Davenport, Rafferty, Timms, Yaron, & Karabinos, 2012). The four modules cover concentration, unit conversion, molar mass, balancing reactions, and using stoichiometry.

The feedback that a student receives is differentiated based on their needs. When a student makes a response and clicks on the "Next" button in the bottom right of the screen, the system evaluates their work on that screen through applying a logic structure that determines the correctness and, if incorrect, the nature of the misconception that the student has. Figure 13.6 shows how the system provides a symbol (! in a triangle) where a hint is available, and the hint text that the student has been given. A student may also call for a hint by pressing the Hint button, but only receives it when the system judges that a hint is needed.

The Use of Games in Assessment

Recently there has been growing interest in how education can harness the attraction and engagement of videogames and turn it to the purpose of learning. In the same way that simulations have been used to create dynamic, interactive assessments, some projects have had success in using videogames for assessment and learning.

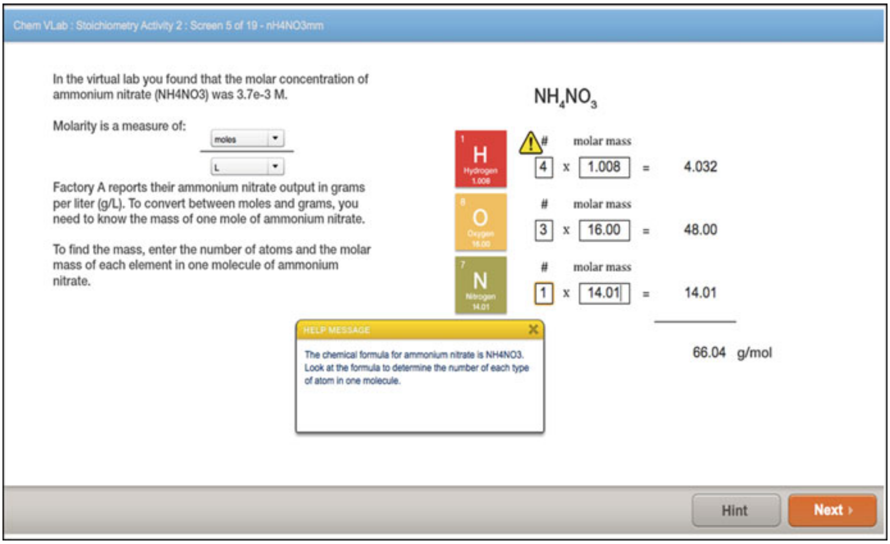

Fig. 13.6 Screenshot that shows how *ChemVlab+* provides feedback and coaching to students

An example of a project that illustrates the promise of the use of games for learning and assessment is *Physics Playground* developed at Florida State University (Shute & Wang, in press). The *Physics Playground* is a computer-based game that uses two-dimensional physics simulations for phenomena such as gravity, mass, potential and kinetic energy, and transfer of momentum. There are 75 levels in the game in which the objective for the student is to guide a green ball past a series of obstacles to hit a red balloon. Everything in the game obeys the basic rules of physics. Using the mouse, players draw coloured objects on the screen, which "come to life" when drawn. For example, if a student draws a pendulum, once it is created it will swing like a pendulum would in the real world and can be used to swing and strike the ball to send it towards the red balloon. Figure 13.7 shows a screenshot from Physics Playground in which the student has created a pendulum that has been used to knock the ball up a slope towards the target balloon. Students can create a range of levers, ramps, pendulums, and springboards and then use them to apply Newtonian mechanics to get the ball to the balloon.

The game incorporates what Shute (2011) calls stealth assessment, which refers to evidence-based assessment that is woven directly and invisibly into the fabric of the learning or gaming environment. During gameplay, students' actions in solving the challengev produce rich sequences of actions that can be used to assess skills or competencies that are the learning goals of the game. Evidence that a student possesses the skills around Newtonian physics is generated by the players' interactions with the game during the processes of play. Usually, in traditional assessment, only the product of an activity is assessed, whereas in *Physics Playground* it is the range of simple machines that the student tries out on their path to solving the challenge which are assessed.

Fig. 13.7 Screenshot from *Physics Playground*

As the flow of data is continuous throughout a sequence of actions the system can use it to incrementally build more and more evidence that the student has (or has not) mastered the specific facts, concepts, or skills that are the target of instruction. In *Physics Playground* the instructional targets are creativity, conscientiousness, and qualitative physics understanding. Evidence of these is defined as the things a student does in the game that would provide information about each particular competency. The game has several levels that increase in difficulty and each level is focused on eliciting evidence related to particular aspects of Newton's laws of motion.

Physics Playground was especially created to be a learning and assessment tool, but it is also possible to modify existing games and embed stealth assessments into them. Shute and Wang (in press) did this with a commercial game called *Plants* vs. *Zombies* which she used to assess problem-solving, which is an important skill among what have been called twenty-first century skills. These twenty-first century skills are ones that occur across domains and include such things as critical thinking, interpersonal skills, and creativity. These kinds of skills are best assessed in interactive online tasks. The challenge in adapting commercial games to become assessment tasks is that, to do so effectively, the assessment developer needs to have access to the source code of the game and it is not usually easy to do so.

Conclusions

In general, there are two types of assessment that teachers of online courses can utilise: ones they create themselves and ones that they obtain from other sources. Those assessments that teachers create themselves are usually built using readily available tools that a teacher can easily access. Often the item types that can be authored using these tools are selected response items of one sort or another, or short constructed response tasks. As described earlier, some of the popular learning management systems now allow some more interactive variants of selected response tasks to be created by the teacher, including such features as drag and drop or hotspots. Such systems also allow teachers to import existing assessment items from outside the learning management system.

The advantage of these is that they are easily available to the teacher and under his/her control. Also, these kinds of items can be scored by the system and the teacher can get summary results quickly.

The disadvantages of these assessments are that they generally are of the traditional teach–stop–assess repeating sequence and teachers need to make sure that they use the outcomes of the assessment to decide what to do next for all students or subgroups of the students.

Another factor that is a potential limitation of these kinds of assessment is that writing good assessment items is a skill that takes time to develop. Novice item writers often make beginner's errors in creating their items, such as using a language level that is above the reading level of the students, thereby introducing an additional layer of difficulty to the item that is unrelated to what might be being tested. We don't have time to go into that in this chapter, unfortunately.

The other kinds of assessment that are illustrated in the second half of this chapter include more advanced methods of measuring learning through tasks that are seamlessly embedded in the learning materials, like the examples shown of *SimScientists*, ChemVlab+, or Physics Playground. These are very suited to online learning and offer a different kind of model of continuous assessment rather than a stop–go method of assessment. Another advantage is that they have sophisticated scoring and feedback systems built into them that can give immediate guidance to learners as well as summary reports to teachers.

The disadvantages of these kinds of assessments are that it is beyond the means or skills of an individual teacher to produce such systems. Also, even if a teacher is trying to find them, there are not many of them yet developed. The examples shown in this chapter are from research projects and, although there is a trend towards developing more of these kinds of assessment, there are still not many commercially available systems at this level of sophistication. This will change over time and what is important is that teachers know what questions to ask of suppliers so that they can judge the quality of the assessment systems on offer.

There are questions teachers can ask related to the model of the content that is the learning focus of the intelligent learning environment. These include the following:

- How is the content knowledge or the skills to be learned represented in the system?

  Look out for whether or not the representation covers all of the skills and knowledge you want your students to acquire. Also beware of representations of the knowledge that appear shallow. For example, maybe it only deals with key skills but not the sub skills that underlie them.

A teacher should also ask questions related to how the system keeps track of the student's level of skills and knowledge as they progress through the module. Questions to ask include

- How does the system model what the learner knows or doesn't know?

Look out for shallow representations such as a simple number of correct problems rather than a judgment about the likelihood that a skill has been mastered.

There are also questions the teacher can ask about the pedagogical model enacted in the system, such as

- What is the pedagogical theory underpinning the approach?

Look out for systems that have no theory of learning, do not report back to the learner or do not report back to the teacher.

Finally, general questions that can be asked of any learning and assessment system include

- What evidence is there that it works?

Look out for shallow evidence that it works, such as the fact that it has only been tried out on a small number of students or if the vendor offers only simple anecdotal reports as evidence.

- Does it meet the learning goals your students have to meet?

Look out for assessments that are not well aligned to your local curriculum standards.

In conclusion, at the time of writing of this chapter we are in the midst of a transition from paper-based assessment to the kinds of assessments that are possible in an online environment. While much progress has been made to replicate simple selected response items and constructed response items into the online environment, the harder task of creating more interactive assessments is still a work in progress. However, as the opportunities offered by online environments continue to expand we can expect to see more innovative ways of assessing student progress and more information available to the learner and the teacher being produced from such systems, which will ultimately allow online learners to enjoy the advantages of learning that is tailored to their needs. Teachers of online learning will have to educate themselves about how such learning and assessment systems work so that they can create tasks for their students when they can and also be informed consumers of more advanced systems.

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Chapter 14
Digital Literacies in a Chinese Secondary School

Xiaofan He and David Wray

Abstract Recent studies of the literacy practices of adolescents in a digital environment have helped us to understand how students deal with digital texts to assist learning. However, most of these studies have focused on Western countries. With the increasing use and penetration of technology into daily life, many schools, colleges and universities in China have also been integrating technology into teaching and learning. Many educators in China believe that technology can introduce a "new direction" into the Chinese education system, which is often stereotyped as characterised by rote learning and extreme exam-orientation. Several schools in China have been engaged with the "Electronic School Bag" (Dian Zi Shu Bao) project which has the purpose of encouraging active learning through the establishment of "a public educational service platform". The study reported here focuses upon one secondary school with digitised classes in Xiamen, China. Students are encouraged to bring their own devices to school and to connect to the Internet and the virtual learning environment in order to be "on-line" at any time. Two classes were studied using a range of qualitative research methods including observations and interviews. The outcomes of this case study are used to suggest some key features of these students' literacy practices in a fully digitised learning environment. Comparisons are made between these "Chinese" features and what is understood from research into similar situations in Western settings.

Keywords Chinese • Secondary school • Literacy practices • Adolescents • Technological environments • Educational practitioners • Technology • Education system • Rote learning • Teaching to the test • Digital literacies • Post-primary school • Secondary school • Digitised classes • Key features • Literacy practices • Students • Digitised learning environment

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Introduction

Since the introduction of information and communication technologies (ICTs) into K-12 schools in the late 1990s in China (Gu, Zhu, & Guo, 2013), technology integration in education has attracted attention from researchers and the central government to get a better idea of learning environment transformations and the resulting technology-supported student outcomes (Ge & Ruan, 2011; Lei, 2010). The "Education and Information Technology 10-Year Development Plan" (2011–2020), issued by the China Ministry of Education, emphasises the integral role in education of information technology over the next decade. Several nationwide projects have been conducted since 2000 such as 'ICT-Accessing or Internet-Connecting Engineering Project for All Elementary and Secondary Schools' (MOE of China, 2000a), "Curriculum of ICT Education for All School Students" (MOE of China, 2000b), "New Cycle of Curriculum Innovation for Basic Education and Integrating of ICT into Curriculum" (MOE of China, 2002). A large amount of investment was made on education technology to carry out these projects. By 2004, 100 billion Yuan (about $13.2 billion) had been spent (Lei, 2010; Zhao, 2005).

In addition to the educational policy emphasis on information and communication technologies, China has the largest population with access to technological devices such as computers, mobile phones and the Internet of any country. According to the 34th "Statistical Survey on the Internet Development in China" issued by the Internet China Network Information Centre (CNNIC) in 2014, Internet users in China had reached 632 million by the end of June 2014 which accounts for 46.9 % of the Chinese population. Based on the survey report, adolescents and young adults seemed to make up a slight majority of Internet users in China: 51.1 % were adolescents and young adults, with 24.5 % aged 10–19 and 30.7 % aged 20–29 (CNNIC, 2014).

Many studies have documented the transformation and challenge that the Chinese traditional K-12 education system is facing because of the ongoing penetration of digital technologies into the curriculum (Lee & Tsai, 2004; Li & Ranieri, 2010; Zhu, 2003). Most studies have focussed on ICT integration into classrooms which means more attention has been paid to how teaching and learning has been affected by new technologies (Ge & Ruan, 2011; Zhao, 2005). Ge, Ruan, and Lu (2012) document and analyse six major kinds of technology tools used in China classrooms. These ICTs are intended to "cultivate students' motivation, interest, and affective development, promoting skills development, and supporting self-regulated, independent literacy learning" (ibid. p. 191).

The relationship between technology and student outcomes has been examined in order to get a broader understanding of the effects of technology on teaching and learning (Lei, 2010). Students' academic performance achieved with the assistance of digital devices can to some extent be used as evidence to explore whether they are "digitally competent" (Li & Ranieri, 2010). Li and Ranieri argue that teenagers who are often labelled as "digital natives" (Prensky, 2001) may not "be able to use ICTs in a competent way" (p. 1041). Lei (2010) claims that student outcomes in the digital age in China are mainly based on how much time they spend on using technology tools which means that "technology is often examined at a very general level" (p. 457). In Lei's study, the idea of "quality of technology use" which includes study of "how technology is used" (p. 458) was introduced to examine different uses in different settings so that a better idea of how students think about reading and learning in a digital environment might be obtained.

In the latest PISA (OECD, 2012) assessment, students aged 15 and 16 from Shanghai in China ranked the first in the world in mathematics, reading and science. However, this tells us little about the role of digital literacy because the area of integration of digital technology in education in China is very under-researched, especially practices outside of classrooms. Many more studies are needed if we are to understand how students see, think and deal with digital learning in different settings (in-school and out-of-school) in China.

Teaching and Learning Changes in Chinese Classrooms

With the increasing penetration of technology into daily life, many schools, colleges and universities in China have been integrating technology into teaching, learning and instruction (Feng, Siu, & Gu, 2011; Fu & Pow, 2011; Ge et al., 2012; Gu et al., 2013; Lai, Guo, & Tsai, 2014; Zhang & Ma, 2011; Zhao & Jiang, 2010; Zheng, Lawrence, Warschauer, & Lin, 2014). Many educators in China are calling for educational reform with the belief that technology would introduce a "new direction" (Feng & Siu, 2010) into the Chinese education system, which is often stereotyped as "exam-oriented and aimed to train students to achieve high scores" (Feng et al., 2011, p. 227).

Some studies have clearly documented the progress of this ICT integration from a historical point of view (Feng et al., 2011; Ge et al., 2012; Xu & Jiao, 2010). Different types of ICT such as multimedia courseware, character coding and inputting systems, mobile technology and communication and collaboration tools, all used in K-12 teaching in China in the last decade have been identified as having some impact on Chinese literacy education (Ge et al., 2012). Many teachers in urban areas of China often take advantage of multimedia tools to integrate "texts, graphics, audio, and animations" (ibid. p. 186) into their teaching. Ge et al. (2012) have suggested that using multimedia courseware in the classroom can encourage students to be more motivated in language learning and help to enhance reading comprehension. Several in-service teachers have found this claim justified based on their students' outcomes after being taught in technology supported learning environments (Wang, 2011). After using multimedia tools in the classroom including audio, image and video, students seem to become more motivated to learn to write Chinese characters and they perform better compared to students who have only used pen and paper (Dai, 2011).

With the pervasive integration of digital technologies in class, teachers' awareness and skills have become an important consideration. In order to respond to the changing teaching and learning environment, in 2004, the Ministry of Education in China launched a tentative set of standards related to primary and secondary teachers' skills with education technologies. This was the first time that China had set a governmental standard explicitly to encourage teachers to become capable of meeting challenges in the digital teaching and learning environment (He, 2005). A series of projects have been carried out under the instruction and direction of the "Educational Technology Skills Training Programme for Primary and Secondary Teachers" which was launched by the MoE in 2005. Teacher training projects range from traditional face-to-face seminars and workshops to fuller online training courses and have aimed to ensure that most teachers get involved in this training in some way (Li, 2007). It has been recognised that professional development for teachers should be sustained and collaborative (Zhang, Liu, Xiong, Zhu, & Liu, 2015) which is reflected in the national CPD programme begun in 2010 (MoE, 2010). Teachers are encouraged to seek for new teaching methods involving the integration of technologies based on personal and peer practical teaching experience. Therefore, a collaborative model for CPD training has increasingly become popular and has been adopted to make sure that teaching in the digital age keeps up with social and technological changes (Liu, Sun, & Wang, 2014). These changes, at the same time, have led to the call for new courses relating to ICT in Education in initial teacher education. Many universities introduced the course Modern Education Technology which require students to demonstrate awareness of educational technologies, skills to use these technologies in class and teaching practices with technologies (Yang, Wang, & Li, 2009). It is clear that teacher training and initial teacher education is being updated with the changing teaching and learning environment in the digital age.

The application of digital technology in the classroom in China has often been seen as involving changes in teachers' use of technology and teaching methods rather than changes in students' participation in digitised classrooms. It would be difficult to know whether students are digitally competent (Li & Ranieri, 2010) or whether they are able to code and decode digital texts if students' experience is limited to looking at the digital texts they are shown in class.

Mobile devices such as smart phones and tablets are becoming popular in teaching and learning because of flexibility and ease of availability (Daniel & Woody, 2013). Some developed cities in China such as Shanghai, Beijing, Guangzhou and Nanjing in recent years have been carrying out "Electronic School Bag" (Dian Zi Shu Bao) projects in order to provide a ubiquitous learning environment based on the need for active learning (Chang & Sheu, 2002), learning performance improvement and "a public educational service platform" (Intel Education Research, 2012, p. 1). Electronic books, digital toolboxes, online digital resources and Internet access are indispensable components put into e-schoolbags to provide creative learning activities and opportunities (Chang & Sheu, 2002). In 2010, Shanghai began to carry out the "Digital Schoolbag" project throughout its kindergartens, primary and secondary schools after the completion of the "all schools connected" to the Internet and other projects during the period 2000–2010 (Intel Education Research, 2012; Xiang, 2013). Implementation of the digital curriculum, individualised e-learning based on mobile learning devices and the establishment of a public educational service platform were clarified as three key foundations of e-schoolbag programmes (Intel Education Research, 2012; Li, 2013). This seems to be a positive move to enhance student-centred learning with the affordances of e-schoolbags because students' learning practice can be tailored based on their previous performance and mastery level. E-schoolbags are designed to focus students' use of devices, which can lead to improvements in word recognition by using built-in dictionaries and in digital literacy skills and IT skills such as information searching and locating (Li, Snow, & White, 2015). Even though the transformation from teacher-centred to student-centred has been an ongoing discussion, there are many studies that have investigated changes of teaching methods, technology application in subjects and conceptual development (e.g. Huang, 2009). Relatively less discussed has been what students' think of digital texts, how they perceive reading texts through different media and changes in learning and reading strategies in the digital education environment.

Digital schoolbag projects can be a useful step towards creating active learning. However, there is a long way to go before e-schoolbags can be used with a large population of students. However, digital schoolbags are not the only way to support literacy education in the digital age. Many studies have suggested that collaborative learning and or interactive activities can improve students' reading comprehension and performance by making use of social networking services or online learning systems (Zhang & Wang, 2008; Zhao, 2008). The notion of literacy as a social practice can be well supported when discussion involves interaction through digital technologies such as online discussion forums or widely accepted social media software. The idea of a knowledge building classroom, based on the concept of a "Knowledge Building Community" (Scardamalia & Bereiter, 2004), was introduced into the "Laboratory Inquiry" in 2006 in Tsinghua University in China. With the support of Web 2.0, students' digital literacy skills including searching, locating, communication and reasoning were developed through theme-based group discussion, and resource sharing (Zhang & Wang, 2008). A sociogram analysis of undergraduate students using an online discussion forum discovered that students were beginning to gain a better understanding of group learning and more willing to get involved in it after experiencing interactions in an online discussion forum (Zhao, 2008). It appears to be the case that students' engagement in collaborative learning in the digital age can be investigated on the one hand based on how much time and how often they interact; on the other hand through what students talk about and in which ways they collaborate to enhance learning improvement.

Apart from some fruitful studies of how teachers adopt technology for changes of teaching methods, there have been quite a few studies of students' use or adoption of technology for reading and learning. Some studies have focussed on technology quality, course quality and flexibility as influencing factors on learner satisfaction in an e-learning environment (e.g. Sun, Tsai, Finger, Chen, & Yeh, 2008). Beliefs about technology use such as users' attitude toward technology and their self-efficacy have also been explored to try to understand the acceptance of technology for learning (Gu et al., 2013; Lai, Khaddage, & Knezek, 2013). Studies of collaborative learning and inquiry-based learning were used to support claims that technology could "enhance learning and improve student achievement for all students" (U.S. Department of Education, 2000, p. 4). It is noticeable that individuals appear quickly to become embedded in digital media in different settings: however, existing studies have not provided a deep understanding of the nature of students' digital literacy practices in the context of their intensive technology usage.

The Present Study

Against the background of current developments in China in terms of digitisation in education, the study reported here aimed to investigate teachers' and students' practices and perceptions of teaching and learning in two classes with the assistance of digital devices, including use of the Internet and specially designed software. This study was guided by the following research questions.

1. What were the learning practices with digital devices of a group of Chinese school students in class and what teaching methods and practices were employed by their teachers? The students in the digitised classrooms being studied were provided with free tablets connected to a system which included three smartboards and one computer.
2. How did teachers in the digitised classes perceive teaching and evaluation under the concept of "educational digitisation" in a fully digitally equipped classroom and how did they perceive their roles in digitised classes?
3. What were students' perceptions of being provided with free tablets and allowed to use digital devices with an Internet connection in class?

The Research Site

The site of this study was a secondary school with approximately 960 students in Southeast China. The school was an "experimental school" which followed the tradition of experimental schools in China in that its brief was to try out new methods to promote teaching and learning. Digitisation education was a project with the target of "non-paper teaching" in this school. Two classrooms were equipped with connected systems of three smartboards on the walls and one computer on a platform at the front of the classroom. Students in these classrooms were seated around round tables, five students to each table, instead of sitting in rows as in traditional classrooms. The size of classes were smaller than the Chinese norm, with no more than 30 students in each class.

Each student was provided with a tablet which could be connected to the classroom system. The connection offered students the chance to get synchronous access to what the teacher demonstrated on the smartboards. Teachers, at the same time, could get immediate insights into students' performance on set work as this was done using the connected tablets.

The database was planned to work as an important platform among students, teachers and parents to make sure all participants were connected to each other. With the assistance of the database, students were expected to get access to online resources at any time and their practices could be observed online by teachers and parents.

Participants, Methods and Data Collection

The two teachers who were in charge of these classes were considered to be participants in this case. Another teacher, who taught in both digitised classes and traditional classes, would also be a participant in an attempt to gain some understanding of the differences between the two types of classes in terms of teaching methods.

Following discussion with the teachers, three students (one girl and two boys) Hong, Ming and Lei (pseudonyms), all 16 years old, were identified as showing diverse use of digital devices and software in learning. Hong, the girl, claimed to carry her smart phone with her all day long. She regarded herself as a "heavy user" of digital devices. She said that she could make full use of digital devices with good self-control without being addicted to them. Ming, one of the boys, viewed himself as a reluctant user of software on the provided devices due to a dissatisfaction with the usefulness. Lei, the second boy, had been forbidden to use personal devices in school time for a period of time because some of his teachers realised that he used digital devices more as an entertainment tool than a learning tool.

Qualitative case study techniques (Stake, 2000) were employed in this study including classroom observations, and individual interviews with participating teachers and students. Students' notes and diary entries about using the provided digital devices for learning were also collected to try to understand potential learning patterns, beliefs about the usefulness of using digital devices in class and recognised obstacles within the new learning environment. In addition, students' feedback on and evaluation of the classes they experienced were also obtained. Table 14.1 below summarises the activities observed within the three subject areas during the study.

Findings

Teacher-Student Relationships in the Digitised Classes

From the classroom observations, students appeared to be given a good deal of autonomy in the class in terms of accessing and using digital devices. They did not spend their time simply looking at the smartboards where the teacher demonstrated an instructional point. They were, instead, given time to use their tablets to search for what they needed for the class. Discussions among students were also encouraged in class based on what they had found through searching on a specific topic. The teachers, meanwhile, were transformed from total instructors to guides in class. They were not, when they were observed, simply delivering a lecture and questioning the whole class. It appeared, therefore, that they were no longer taking the authority role in terms of knowledge and technology in class. Interactions between teachers and students were also observed when both parties were using software through the tablets and the connected system.

Table 14.1 Observed classroom activities

History	Chemistry	Politics
Students' 5-min test of last lesson on tablet (not in every lesson)	Students' 5-min test of last lesson on tablet (not in every lesson)	Students' 5-min test of last lesson on tablet (not in every lesson)
Teacher lecturing for about 20 min	Teacher lecturing throughout the whole lesson including using video clips	Teacher lecturing for about 20 min
Students using tablets to search for relative information online	Students doing quizzes regarding specific knowledge points on tablets	Students doing quizzes on tablets
Students' discussion in group regarding information they had found and that obtained from teacher	Teacher varying quizzes based on students' grasp of knowledge and performance on the last quiz	Teacher's analysis of students' outcome of quizzes
Students' talk based on the discussion in class	Students' discussion in group regarding practical applications in real life	Students using tablets to search for the latest news related to the lesson
Teacher's comments and other online learning material shared	Students' using tablets to search for some chemical reactions	Students' discussion in group based on what they had searched
5-min text on tablets about the lesson (Not in every class)	Students' using tablets to search for examples to support their talk	Students' talk in class according to the discussion
Teacher assigning homework	Teacher's comments on students' talk	Teacher s comments on students' talk
	Teacher assigning homework	Teacher assigning homework

Practices Across Subjects

Teachers' teaching practices and students' learning practices in digitised classes were found to be different from subject to subject. Based on observations of the teaching of the three participating teachers in this case study (teaching Chemistry, Politics and History respectively), the Chemistry teacher tended to allocate less time to students to search for information on a subject. Instead, software installed on both tablets and on the system was used more frequently. This teacher claimed to be able to tell the students' grasp of knowledge as soon as they had finished their exercises using the software. New material was set based upon this analysis of the students' performances.

However, the History and Politics teachers were more willing to ask students to search for related subject information to broaden their knowledge and boost their critical thinking. These teachers tended to provide technical and academic support in the class. Their students often used the tablets for information and some students continued their work after school time.

Perceived Usefulness of the Digital Approaches

The students in this case study viewed themselves as "digital natives" (Prensky, 2001), that is, born and brought up with digital technologies, and they believed that digital devices were useful tools for expanding knowledge and solving problems in school work. Some applications downloaded by students were frequently used because, as they argued, this was a quick way to get answers with detailed analysis of questions.

The teachers, however, stated that technology was a new method which could be attractive for students. Digital devices and educational software were regarded as supplementary to instruction and were thought to deepen students' understanding of knowledge. Teaching methods within the digital environment had been explored and adjusted in order to gain the expected learning and teaching outcomes.

Acceptance of New Technology

The acceptance of technology in education should be explored from aspects including availability (Hutchison & Reinking, 2011) of hardware and software, ease of use (McGill & Hobbs, 2008), and personal competencies (Li & Ranieri, 2010). In this case study, one teacher tended not to use the installed software because he admitted that it was not well developed and suffered from a poor Internet connection which could waste a lot of time when the software stopped because of technological problems. Some teachers in the digitised classes admitted that they were not yet fully competent at using digital devices which could hinder their acceptance of new methods in teaching. The students' developed skills of using digital devices and applications were helping them embrace this new way of learning with excitement and curiosity even though they also found that the installed software was not user-friendly at some points.

Emerging and Potential Obstacles

The teachers in this case study indicated that their judgements about students' performance in the new digital learning environment were hampered by a lack of suitable methods of evaluation. Traditional assessment such as paper-based exams was the only approach to evaluating students' skills and performance that they had experience of. There had been discussion among teachers in the school concerning possible new forms of assessment to measure students' learning outcomes.

The school policy concerning students' use of digital devices and the Internet was not well settled before the project began, which resulted in some inappropriate use in school in periods when students could find some time. Students also demonstrated that they were not always able to control themselves not to use these devices for the purpose of entertainment because they could reach them at any time without restriction and the teacher could not trace what they were doing on devices if they were not using the database.

Discussion

This study has offered a panoramic picture of the perceptions of some teachers and students about various aspects of literacy practices in digitised classes in a Chinese secondary school. The study has revealed that new teaching methods with educational software were being employed and that students were able to learn within an always "on-line" environment. The exploration of perceptions of availability and usefulness and of the obstacles to successful teaching and learning have suggested some factors that might be essential for the "digitisation of education" in China. This case study, therefore, extends previous studies of integration of technologies into education in China. Some key issues have emerged.

Regarding students' practices of using digital devices with autonomy in class, the findings suggested that students were allocated more time during class for searching for information about the topic of the class. The teacher of the class was often invited to join students' discussion to provide support when they came across problems in using the educational software or digital devices. The influence of the traditional Confucian heritage (Lau & Chen, 2013; Zhang, 2008a, 2008b), to some extent, appeared less noticeable in the digital teaching and learning environment even though teachers remained in charge of a digital system which was used for instruction. Digitised classes in this case study tended to adopt student-centred approaches (Zhong, 2006) to promote students' abilities to gather information and to think critically. Student autonomy appeared to be at a much higher level than usually found in traditional classes (Lau & Chen, 2013).

However, it has been argued that too much freedom for students in class could cause ineffective teaching (Lau & Chen, 2013; Wang, 2008). From classroom observations and an interview with the teacher who was teaching History in both digitised classes and traditional classes, effective teaching could be delivered as long as the connection between the school software system and students' tablets was working well without technological problems.

From the observation of classrooms, each group of five students in this case study were arranged to be seated around a round table. This promoted greater opportunities for group discussions than would have been afforded by students sitting in rows as in traditional classrooms. Chinese students in highly competitive environments are found to have high extrinsic motivation (Lau & Chen, 2013). In this case study, however, intrinsic motivation appeared to be operating. Students indicated that the discussion of their online searches for a specific topic encouraged them to understand others' thoughts about this topic. As the students attested, sharing learning resources via digital devices through online groups in both in-school and out-of-school settings stimulated their desire to learn more and help to cultivate the habit of learning at any time at any place.

The practices of the teachers and students in this case study showed that technologies were not simply integrated into teaching instruction in that the teachers "simply find ways to use ICTs to complete tasks they previously did without ICTs" (Stolle, 2008, p. 66). Students were not simply sitting in rows, looking at a demonstration on the big white screen, which would have indicated an integration but not a transformative one. From the beginning, however, the digitised classes project in this school were guided by the concept of interactions among students, teachers and parents and self-regulated learning. Based on this, students were required to do good preparation and prevision for the class because the teacher would only spend 15 min on lecturing. After the teacher finished the planned teaching task of the class, 30 min would then be allocated to students to search for information related to the specific topic of the class and for discussions with others based on the information that they had located from the Internet or the database. This may not sound like transformation, but in the context of Chinese schooling, it represents a huge change to normal classroom practice.

Teaching methods appeared to differ depending upon the subject being taught. The software system and the database were used as resources to meet students' needs for expanding information in subjects such as Chinese, English, Politics and History. In class, teachers of these subjects often used the installed software to boost the richness of information when lecturing. Students were allowed to use the digital devices when they had problems after the teaching task was completed. Teaching and learning practices in Science classes, however, were designed differently. When the teacher had finished the direct teaching part of the class, students were required to answer some questions including multiple choices, blank filling, calculating and application of knowledge on tablets which were transmitted from the software system controlled by the teacher. Students' performance was analysed by the system and the result could be used to assess students' grasp of knowledge.

Students, meanwhile, appeared to be becoming more familiar with using different learning methods to suit the needs of a subject. Students in traditional classes who have access to various digital texts are still regarded as rote learners (Ho, Peng, & Chan, 2001) because students have little chance to generate their own thoughts about the class and school work. In this case study, students had begun to get into the habit of finding weaknesses in their learning and grasp of knowledge though the records kept by the system and database. The interactions among students and teachers mediated by technologies both in-class and after-class were also helpful for students to get beyond traditional stereotypes of Chinese students as passive rote learners (Zhang & Wu, 2009). Thus, technologies were not only used as a vehicle to demonstrate digital texts for study. A range of uses of technologies were being developed based on the needs of the subject but with the aim of encouraging intrinsic motivation, group work, interaction and self-regulated learning.

Teenagers are often regarded as "digital natives" because they have grown up with digital devices. Teachers, however, have been labelled as "digital immigrants" (Prensky, 2001) as they have had to transform themselves to take account of a digital environment. Although this distinction is not universally accepted, it does suggest that the use and acceptance of new technologies in education might differ between students and teachers (Gu et al., 2013). The outcomes of this case study suggest that the gap in terms of acceptance of new technologies between students and teachers is not huge, as both groups had had to accept new ways of teaching and learning in their digitised classes. The availability of digital devices, software, applications and the Internet appeared to have encouraged teachers to integrate technologies into their teaching (Hutchison & Reinking, 2011), albeit in different ways. Most teachers in the digitised classes in this study showed the tendency to make use of digital technologies in teaching. They explained that various functions of technologies and the potential promotion of learning performance drove them to teach digitally within the network which was mediated by technologies. Technological skills, however, did hinder the degree of acceptance of new ways of teaching and learning. Teachers who were not skilled with technologies and the software in this study were more reluctant users of the new technology. Some of the ways in which these teachers made use of technologies in digitised classes made their students feel there was little difference from learning in the traditional way.

Even though these teachers and students had accepted, to different degrees, a new teaching and learning environment with new technologies, their beliefs about usefulness, ease of use and the Internet did affect their acceptance. The unreliability of a poor Internet connection often pushed teachers to give up employing new methods. Internet disconnection caused uneasiness among both teachers and students resulting not only in wasting time but also in the disorganisation of teaching and learning tasks. In addition, the incompatibility caused by not well developed software required teachers to spend more time on preparation for the class. Students sometime became confused because what appeared on their tablets was not the same as the teacher was demonstrating on the smartboard.

System unreliability was just one of the obstacles in the way of successful technology integration. Consensus about the effects of various obstacles to the integration of technologies into teaching has not proved easy to reach (Hutchison & Reinking, 2011). Factors that affect the degree of acceptance might be common for the integration of technologies or simply for any new methods in education (Sun et al., 2008). In this case study, the project of digitalising education had encountered several obstacles. One teacher who was teaching in both digitised and traditional classes realised that students from digitised classes were not satisfied with the way that their performance was evaluated. Paper-based examinations were still the most frequently used methods to evaluate students' performance even though these were e-learners within a fully digitally equipped environment. Diversity in assessment (Thurmond, Wambach, Connors, & Frey, 2002) within a digital learning environment may potentially make students think that their efforts are well assessed (Sun et al., 2008) and their overall performance is valued. Teachers in this study often received feedback from students about the need for them to pay attention to their efforts outside of class. One participating student explained that interactions between students and teachers had been promoted overall; however, students were still classified as a certain group of people based on their scores in exams. He then decided not to use tablets unless he was required because what he had done was "invisible" to teachers and parents. Spending more time on doing paper-based work was regarded as the best and easiest way to be classified as a good student.

Based on students' feedback about the lack of diversity in assessment, the teachers were considering using other ways to evaluate students' efforts both in-class and after-class. However, due to the highly competitive educational system in China (Mok, Fan, & Pang, 2007), newly added evaluation practices might negatively influence students' final results in the national examinations because they are senior secondary school students under the "influence of high-stake public examination" (Lau & Chen, 2013, p. 1096). As the teachers in this case study explained, changes of evaluation or assessment of students' performance is a long way away in China which holds back the pace of reform in education in China. In this case, frequent feedback from teachers to students worked as a helpful way of promoting students' motivation to employ new learning methods. Nevertheless, even then, several students were reluctant to fully engage in this. Therefore, evaluation practices within the digital environment probably need to be amended based on students' experience and feedback.

The findings suggest that there was little regulation in terms of guiding students' use of digital devices in after-class time. It seemed to be quite easy for some students to get addicted to using digital devices for entertainment. One case study student, who thought himself addicted to games and surfing the Internet, admitted that access to digital devices with the Internet connection at any time in school had offered him the chance to access anything for fun. This suggests that appropriate guidance in using digital devices needs to be available, especially when students are undergoing the transformation from paper-based studying to digital-based learning.

Limitations

This case study was carried out within a short period of time and clearly may not fully cover teachers' and students' practices in both in-class and after-class settings with the use of digital devices and the system. Transformation of rote learning and traditional teaching methods cannot be well explored within such a limited time-scale and using such a limited range of methods. Recent studies of digital learning, focussed upon diverse subjects, using large scale samples and employing various methods (Bauer & Kenton, 2005; Honan, 2008; Hutchison & Reinking, 2011; Stolle, 2008) have highlighted the need for a more complete understanding of education in the digital age. Additionally, a longitudinal study may well have been able to explore changes in beliefs, perceptions, practices and interactions among teachers, students and parents with improvements of software and regulations. Newer methods, such as the use of students' diaries recording their use of digital devices in digitised classes, may be required for a more detailed and full record of learning practices.

Due to the limits of time and the difficulties inherent in getting into contact with parents, how parents perceive their children learning in the digital environment is still unknown. Parents' attitudes and beliefs toward the use of digital devices may to some extent influence students' choices of learning methods. In depth interviews with parents would need to be included in a further study.

Conclusion and Implications

This case study provided an overview of teaching and learning practices in two digitised classes in a secondary school in China. The findings of the present study will, hopefully, have enriched understandings of digital practices in education, perceptions of digitisation of education and of the obstacles in the way of this in China, against the background of educational reform in the twenty-first century.

From the case study discussed here, it seems that the application of digital teaching has a subtle influence on the relationship between teachers and students and between students and students. Teachers gradually move from their traditional role as authority. In addition, students' autonomy in digital learning in class boosts interactions and intrinsic motivation. Since education in China is deeply influenced by the Confucian heritage, the degree of students' autonomy needs be carefully monitored so that effective learning can be guaranteed.

Digitisation of education is not simply using technologies as supplementary tools for presenting material. Teaching practices vary from subject to subject which may imply that teaching methods and the use of digital devices should be designed based on the task of the class. Studies of digital teaching and learning within specific subjects are required to help us understand differences in practice in more detail. The acceptance of digital teaching and learning appears to be positively related to perceptions of its usefulness, its availability and of teachers' personal competencies. Only when all dimensions of technologies, users and the overall educational environment (Sun et al., 2008) are well prepared, can acceptance be achieved to promote the desired educational outcomes.

Understanding the obstacles identified in this case study can be useful to other projects concerned with the digitisation of education in China. More efforts need to be put in to research how to help students make a stable transformation from traditional to digital learners. Parents as potential participants in digital education should also be studied to understand how the digitisation of education can work to link learning and living in the digital age.

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Chapter 15
The Paradoxical Art of Designing for Emergence

Stephen Mark Collis

Abstract This chapter explores the role of digital technologies in collaborative open space learning programs developed at Northern Beaches Christian School in Sydney, Australia. The chapter begins by recounting the role of an in-house innovation incubator called Sydney Centre for Innovation in Learning in nurturing a school philosophy that values emergent interactivity, and offers justification for this philosophy using Self-Determination Theory. It describes a number of ensuing open space learning designs, making specific reference to the practical use of digital technologies. The chapter concludes by proposing ecological design language that interprets structures in physical, virtual, and cultural space by their ability to facilitate emergent, unscripted interactions between people, their environment, and information. It emphasizes the paradoxical importance of linearity, constraint, and expert teaching in learning designs that set the scene for emergence to occur.

Keywords Flexible learning environments • Emergence • Self-determination theory • Moodle • Learning design • Learning space design • Flipped learning

A Design Framework for Emergent Learning

> *All* the students were on-task, *all* the time. If I didn't know better I'd have thought that the students were actors—and I was in some kind of Truman Show experience. —Andrew Douch, after a half-day visit to our school (Douch, 2012)

In this chapter I explore the place of digital technologies within an ecosystem of structures which can promote or constrain interactions between people, their environment, and information. I base this exploration on a range of designs that teaching staff evolved during an intense 10-year journey of innovation at a K to 12 school in Sydney, Australia.

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A Lived Experience of Innovation and Transformation

The key source material for the reflections in this chapter is the lived experience of Northern Beaches Christian School (NBCS), through my own interpretation in the period from 2002 to 2015 as first a classroom teacher, then school leader, and eventually a consultant working on behalf of our school.

I would describe NBCS in 2002 as “industrial” in structure, consisting of single cell classrooms populated with rows of desks facing the teacher’s space at the front. The default pedagogical practices relied heavily on teacher-delivered content according to a teacher-crafted schedule.

Our principal Stephen Harris had joined the school in 1999 and had set about disrupting these structures with some success. In 2005, he greatly accelerated our change journey by announcing the launch of “Sydney Centre for Innovation in Learning” (SCIL) as a research and innovation unit embedded in the school. SCIL became a rather informal banner under which we could champion and celebrate innovative culture, processes, people and projects. For instance, a teacher could call themselves a “SCIL Associate” or launch a “SCIL” project. Certain leaders were associated with SCIL and had responsive wildcard functions, fanning into flame moments of inspiration among staff whenever these occurred with collegial and logistical support. Its mottos were “do, then think,” “ready, fire, aim,” and “question everything.” The SCIL leadership roles were also deliberately subversive, allowing ideas to be implemented without having to navigate a formalised bureaucracy.

David Price (OBE) of the UK Innovation Unit has characterised SCIL as “what would have happened had Thomas Edison been an educator, rather than an inventor.” (Price, 2013)

Between 2005 and 2010, under the banner of SCIL, a range of new learning structures were prototyped and tested by a group of enthusiastic teachers that might be called the “coalition of the willing.”

These prototypes were often inspired by ideas we had identified in a series of international research tours, documented in Harris (2005), Harris (2006), and Linfoot (2006). The establishment and early operations of SCIL within Northern Beaches Christian School, and translation of research insights around virtual space into day to day practice, are documented in detail in Harris (2008), Linfoot (2007), and Harris (2010a, 2010b).

After 2010 we experienced a cascade of further innovations around the school as the “coalition” tipped and became a majority.

Our rationale for change during this time was largely philosophical, driven principally by a vision for high student engagement. We grew a shared school narrative that interpreted our core challenge as being how to engage and activate all our students to the highest degree possible. The data we used to measure engagement was sensory and informal, and processed through shared conversations. We didn’t feel we needed a number or a metric to tell us what we could see with our own eyes. In practical terms, were the students moving, talking, contributing and taking initiative? If so, we had a promising design. If not, we needed to change it quick.

I have recently found in Self-Determination Theory (SDT) better language to describe our philosophy and evaluative process (Deci & Ryan, 2008). SDT identifies three critical ingredients that promote growth and wellbeing in individuals and communities: autonomy, relatedness, and competence. I will use these terms in this chapter as a more robust proxy for what we as a school called "engagement" when evaluating our progress. The proxy is a fair one; the SDT terms simply bring nuance:

> SDT suggests that it is part of the adaptive design of the human organism to engage interesting activities, to exercise capacities, to pursue connectedness in social groups, and to integrate intrapsychic and interpersonal experiences into a relative unity. (Deci & Ryan, 2000, p. 229)

If our measurement of success consisted solely of student competence then we might have focused entirely on data about learning achievement to guide our learning designs. While we certainly did consult such data, and while it steadily strengthened during this time, we were more concerned with getting the energy up in the room: having students moving, talking, taking initiative; concerns that fit neatly into the SDT categories of relatedness and autonomy. It did not surprise us that in pursuing deeper student engagement, we saw a steady improvement in data from external testing showing improved learning outcomes. However, our pursuit of engagement was not a means to end, but was valued in its own right, for both students and for teachers. This was matter of school culture, identity, and philosophy.

I have used the phrase "emergent learning" in the chapter title to capture some of this philosophy. The sense of the word "emergent" is that unexpected and unscripted interactions take place between people, space, and information. Emergence is implied by the SDT categories of relatedness and autonomy; both require genuine freedom and therefore transcend our ability to script and control.

In the same way as we pursued designs that created space for emergent interactivity, the evolution of the designs themselves was emergent. Under the banner of SCIL we embraced trial and error, and grew a high-trust environment. We did not have a scripted master plan for school improvement; instead we felt our way forward through a series of iterated experimental designs.

Below I describe some of these designs. Then, I explore new language that we developed to identify a repertoire of design structures that emerged over the years as aligning with our philosophy. In particular, I explore how digital technologies found their place within a holistic design framework whose core affordances and constraints (Greeno, 1994) are mapped back to the interactivity suggested by both SDT and our stated ambition to have students "engage."

An Early Prototype using Bloom's/Gardner's Matrix

One of the early prototypes at our school saw a team of five High School teachers come together for a few hours a week for a program integrating History, Geography, and English, which we called "The Matrix." The three subjects still continued in traditional form—"The Matrix" was an additional subject using time peeled away from those main linear programs. It took place in a large shared space created by opening the concertina doors separating five traditional classrooms.

During Matrix time, students opted into one of a large number of learning challenges presented on a giant poster with vertical and horizontal grid lines. The horizontal axis had rows categorised by Gardner's multiple intelligences, and the vertical axis had columns categorised by Bloom's taxonomy. This structure is well known by teachers, and was apparently first conceived, popularised, and christened "the Matrix" by Ralph Pirozzo (Rao, 2009). In our implementation, each table cell contained a brief description of a challenge keyed through to learning outcomes. Students would choose an activity, and then find a "stimulus card"—a corresponding laminated A4 card with more details and resources.

Some tasks were open ended, and some quite prescriptive. Each task was worth a number of points, with each student setting targets for how many points to earn over a 10 week term. Each term we moved to a fresh Matrix with a new theme and new target for points.

Despite some fairly obvious design flaws (a bewilderingly high number of choices, no expert input, no linearity at all, no formalised collaborative structure) the Matrix was a stunningly popular with students and the teaching team.

We filmed various students from Year 7 and from a similar program in Year 5 and 6 as they explained why the liked the program. You can watch the Video 1.

A dominant theme in the student feedback is autonomy: being freed from the tyranny of teacher talk, and being free to choose what to do and when. Yet this freedom was experienced within carefully curated structures. It was certainly not a vacuum.

A critical element to this early design was the notion of some kind of map that students could consult of their own accord that set out a series of curated learning challenges. In the Matrix program this took the form of a poster on the wall and a series of laminated A4 stimulus cards. In later designs we used a web-based Learning Management System (LMS) as a space where we could communicate different options to students. However the LMS was following the same principle is the original Matrix poster on the wall. If we are going to give students choices, but don't want them to have to choose in the context of a vacuum, how will they know what choices are available? Where will the scaffolding go? We needed a space from which to broadcast this information (Figs. 15.1 and 15.2).

Both our Matrix poster and later web-based matrices had the same design function: to broadcast information to students at the point of need. Both increased interactivity in the program design by releasing the teacher from having to be the broadcaster of information, and the students from having to be quiet and listen. The information was there when it was needed.

Later Designs

Our original Matrix program ran from 2007 to 2012. During this period a wide range of other designs emerged around our school.

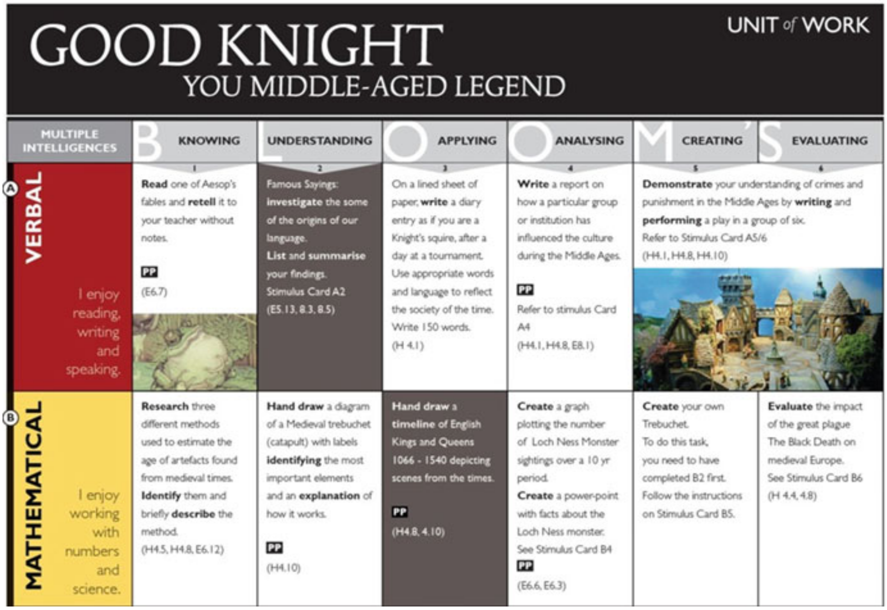


Fig. 15.1 First two rows from a Matrix poster

This time-lapse video shows a number of these designs in succession. The video pauses at key moments and I shall refer to each of these in sequence below (Video 2).

In each design multiple spaces and classes have been brought together and teachers are working in a team.

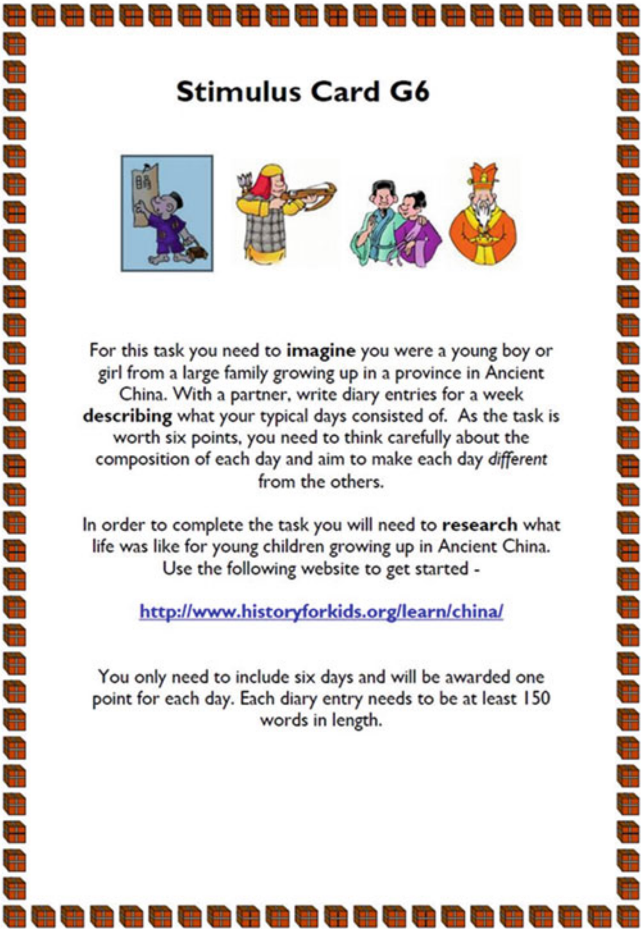
The first scene shows a Year 7 Visual Arts lesson. At the first pause two teachers communicate briefly before class begins. There is no formal start to the class—students experience high autonomy from the moment they arrive.

In this design, students choose from six different projects, completing one each term. Instead of scaffolding these projects with a poster or task cards, a richer set of multimedia scaffolding was brought together by the teaching staff and published on our Learning Management System (LMS)—Moodle. Moodle allows teachers to design their own web pages, populated with resources and interactive tools—e-mail forums, quizzes, wikis, and the like.

The screen-shots in Figs. 15.3 and 15.4 show the Moodle pages for the Visual Arts program. It includes "flipped learning" videos created by the program teachers.

All students blogged their progress and tracked their projects and blog sites on a central collaborative Google Doc. These are shown in Figs. 15.5 and 15.6.

The notion of online learning can conjure up a vision of students buried in laptops, cut off from the world. However, in this program, where the technology is used in the context of a holistic design built to enhance engagement, there is a great deal of collaboration among students, and lots of 1 on 1 "on the shoulder" guidance by the teacher. The second pause in the video shows such a moment.



Stimulus Card G6

For this task you need to **imagine** you were a young boy or girl from a large family growing up in a province in Ancient China. With a partner, write diary entries for a week **describing** what your typical days consisted of. As the task is worth six points, you need to think carefully about the composition of each day and aim to make each day *different* from the others.

In order to complete the task you will need to **research** what life was like for young children growing up in Ancient China. Use the following website to get started -

http://www.historyforkids.org/learn/china/

You only need to include six days and will be awarded one point for each day. Each diary entry needs to be at least 150 words in length.

Fig. 15.2 A Matrix stimulus card

A close examination of the video reveals a group session lead by the other teacher in the background. This was run for students who are pursuing one of the projects, and was a compulsory session to allow the teacher to provide necessary expert input.

This teacher-lead session has an informational function that is comparable to both the original printed Matrix poster and our use of our LMS to scaffold choices. In each instance, information is being broadcast. So what is the different between a teacher and a poster on the wall? In my observation, if teacher instruction is delivered to large groups of students with minimal interactivity, there is very little difference indeed. In the time-lapse video, we see a far more interactive form of expert input. The students gathered around in a small group, sharing a space, in a special moment in time.

The second scene of the time-lapse video, shows a program of greater scale and complexity. The program takes place in what we call the "Zone." The Zone consists of 180 students from Year 5 and Year 6, and their six teachers, who work all day, every

Fig. 15.3 Students click to choose a project

day, in a very large shared space. The video shows an integrated project with a Science focus, which runs for about a term. The video only shows half of the space, with the other half accessible down a large central staircase in the middle of the building.

In the video background you can see teacher Mr Daniel Wearne providing a teacher-lead session related to one of a number of Science activities that were available to students. Mr Wearne repeated the session several times over a fortnight, with different students opting in at different times. Other teacher-lead sessions were available in other locations, including outside (Figs. 15.7 and 15.8).

In the foreground, a student works by himself, but is visited by two of his peers for a short interaction where they appear to discuss his progress.

It is worth noticing the behaviors of the other teachers in the video, moving from student to student or group to group. There is a special moment where teacher Ms Katie Morrison emerges from the stairs and scans the space to see where she is needed.

In the third scene of the video there are two Year 8 Music classes in a shared space. The program was developed and is led by Mr Brad Fuller and Mr Peter Orenstein. The learning space consists of a series of stations in a sequence that mimics a typical compositional and performance process. In groups of up to seven, students compose music at one station, jam together with instruments at the next,

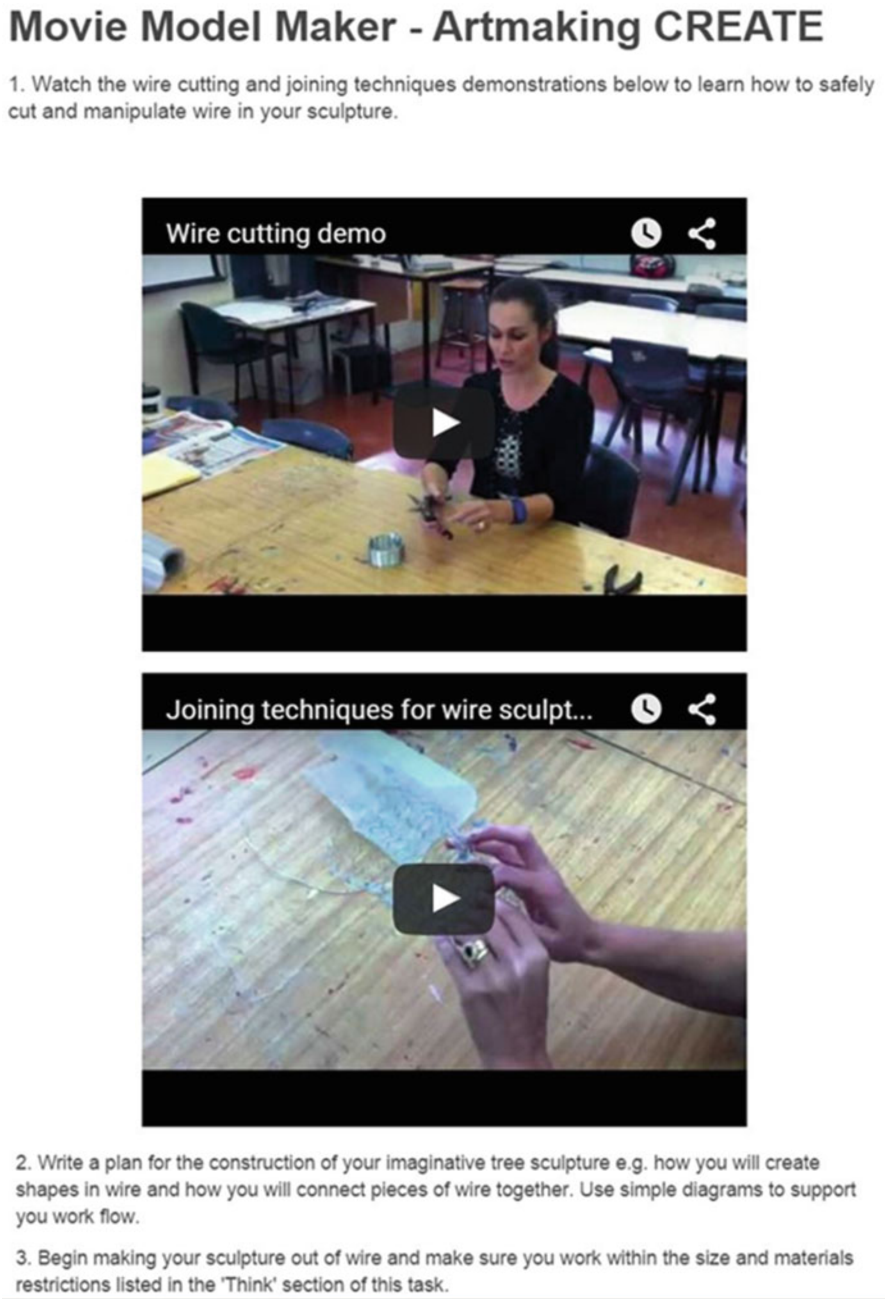
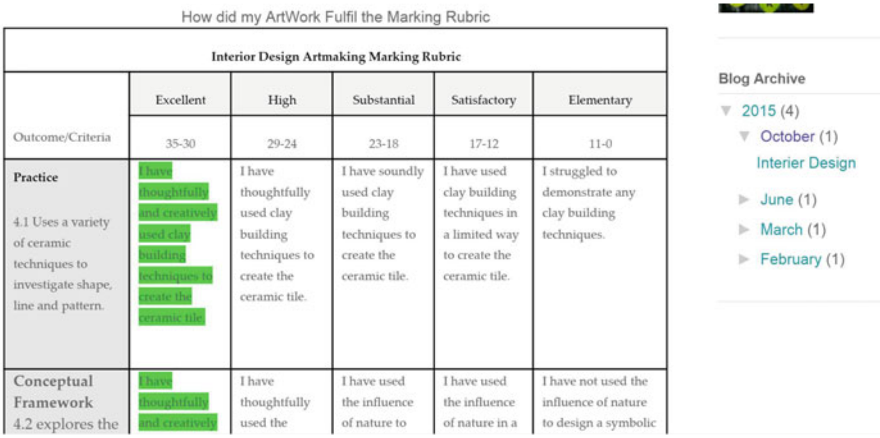


Fig. 15.4 Instructions and videos on our LMS



How did my ArtWork Fulfil the Marking Rubric

Interior Design Artmaking Marking Rubric					
Outcome/Criteria	Excellent 35-30	High 29-24	Substantial 23-18	Satisfactory 17-12	Elementary 11-0
Practice 4.1 Uses a variety of ceramic techniques to investigate shape, line and pattern.	I have thoughtfully and creatively used clay building techniques to create the ceramic tile	I have thoughtfully used clay building techniques to create the ceramic tile.	I have soundly used clay building techniques to create the ceramic tile.	I have used clay building techniques in a limited way to create the ceramic tile.	I struggled to demonstrate any clay building techniques.
Conceptual Framework 4.2 explores the	I have thoughtfully and creatively	I have thoughtfully used the	I have used the influence of nature to	I have used the influence of nature in a	I have not used the influence of nature to design a symbolic

Fig. 15.5 A student blog post

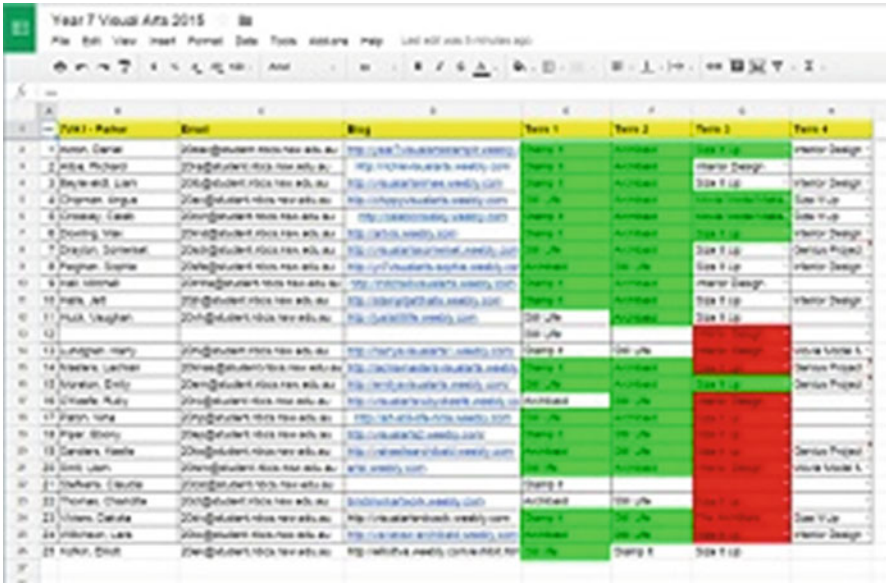


Fig. 15.6 Google doc tracking dashboard (deliberately blurred)

transcribe the music at the next station, perform it to the class on the stage, and then record it in one of two side music studios. Students work in the same group all year, rotating from station to station every 15 min according to a dashboard set up on a shared Google doc (Figs. 15.9 and 15.10).

Two of the stations involve direct teacher input. One of these stations is visible on the right of the screen.

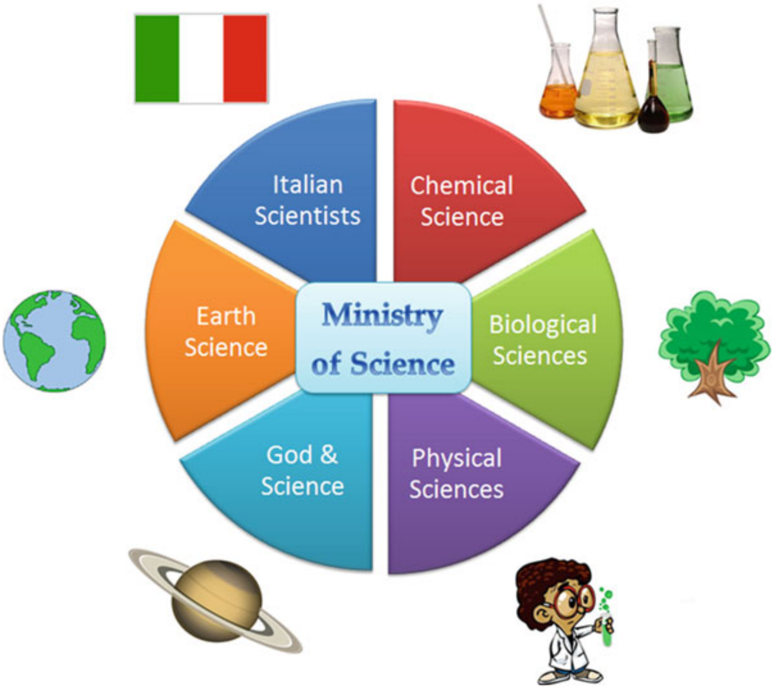


Fig. 15.7 Clickable graphic on our LMS in the Zone program

Switched on!

Big Question: ***How does a circuit work?***

Goal of Task: *The goal of this task is to work with a partner to design a circuit using a battery, electrical wire and a bulb that will allow the bulb to light up.*

Things needed to complete task:

- Research
- iThink book
- Bulb
- 2 pieces of electrical wire with insulation stripped on the ends
- Battery

Steps: *(Complete in order to produce a 'quality matrix task')*

1. Predict as a team how you could connect the equipment. Draw your predictions.
2. Provide reasons for why you think your prediction will work.
3. Create your light circuit.
4. Observe and record what happened in your circuit.

Fig. 15.8 Part of a digital stimulus card in the Zone

Fig. 15.9 Clickable music stations

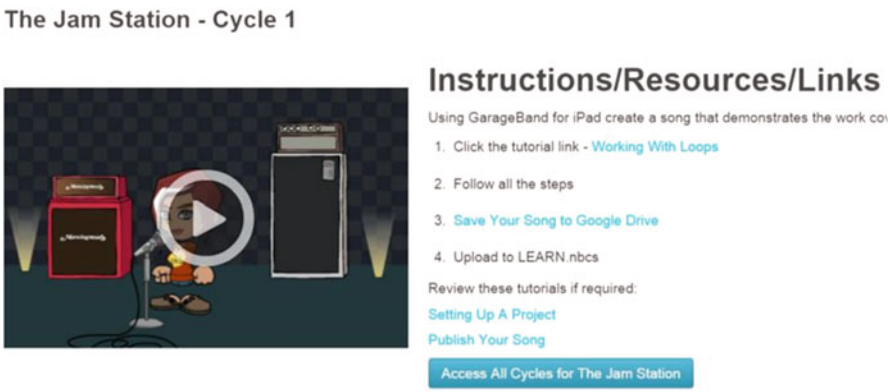


Fig. 15.10 Music online instructions and video

The final scene of the video, before returning to the Zone program from a different angle, shows two Year 8 French classes in a similar paired combination. The particular unit on the video is called “Bootcamp” and consists of six cycles around a variety of communicative learning outcomes. Each cycle begins with a teacher-lead session, followed by video training and then a mini-Matrix with a range of language games and activities that address the learning outcome (Figs. 15.11 and 15.12).

Most of our other learning designs, from Kindergarten to Year 12, involve similar structures to varying degrees and in varying combination. For instance, a small senior elective class might take place in a single-cell classroom with just one teacher, but still offer choice and flipped learning resources. Our kindergar-

Fig. 15.11 French clickable graphic

ten program does not require students to consult a web portal, but is co-taught in a flexible learning environment with a program that values student choice.

I have noticed several misconceptions that are very common among fellow educators when they first observe our programs: First, that greater student autonomy correlates with less structure and constraint in our program designs, whereas we believe our programs simply have more sophisticated structure and constraint. Second, that teacher-delivered instruction has to be de-emphasised to make room for student-driven learning, whereas we believe that because teacher expertise is so powerful we need to be savvy about offering it to the right learners at the right time. Third, that, given choice, some students will choose not to engage, whereas our experience has been that they all engage to a deeper level than in a traditional set up. Finally, that students will get lost in the complexity of the programs, whereas we have very deliberate tracking mechanisms to make progress transparent.

There is something of a paradigm shift implicated here. Many schools are seeking alternatives to default modes of teaching. Our challenge is perhaps that the defaults are so well known, whereas the alternatives are less familiar.

As we have chartered unfamiliar design territory we have had to find new language to normalise a repertoire of new structures. I will unpack this language below.

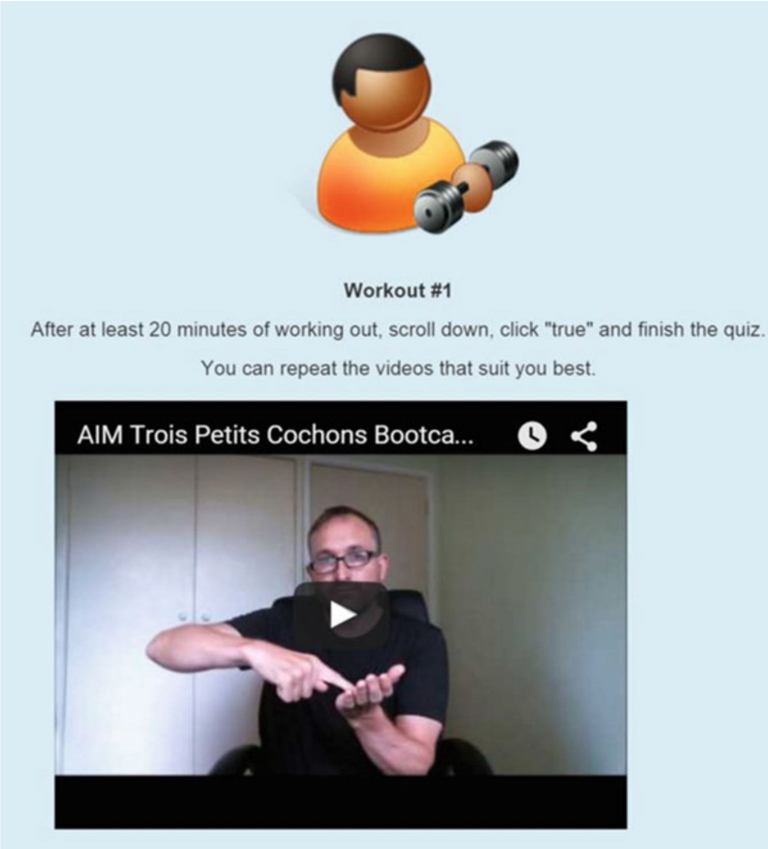


Fig. 15.12 French flipped learning video

The Learning Landscape

Our previous more traditional pedagogical designs tended to sequence teaching and learning activities in a linear process, leaning heavily on certain concepts of cause and effect: the teacher does THIS, then the students do THAT, and the result is learning. Of course, great teachers improvise and are highly responsive. Our challenge was to allow such responsiveness to permeate the entire learning design.

We have used the phrase "learning landscape" to invoke a vision of complex interactive and responsive cause–effect loops between people, space, and information: in short, an ecosystem. In a learning landscape, teacher–student interactions may still be centrally important, but are not exhaustive and all-dominating.

Yeoman explores the complexity of such emergent interactions in her thesis "Habits and Habitats: an Ethnology of Learning Entanglement" (Yeoman, 2015), where she applies the Activity Centred Analysis and Design (ACAD) framework of Goodyear and Carvalho (2013, 2014a, 2014b), to her observation of the Zone program at my school that we saw previously in the time-lapse video. Her observation was extensive in scope, comprising no fewer than 549 h throughout 2012.

Yeoman's refers to both "material ecology" (Yeoman, 2015, p. 26) and a related concept: Ingold's (2010) concept of entanglement: "a meshwork of interwoven lines of growth and movement" (p. 3) and "an ontology that assigns primacy to processes of formation as against their final products" (p. 2).

Our internal idiomatic phrase "learning landscape" evolved separately to these works but is very much in the same spirit.

Linearity and Personalization

The term "landscape" deliberately activates teachers' visual imaginations and taps into cognitive architecture that is already adept at tracking and making sense of complex interactions.

A landscape has a mix of structures that create freedoms and constraints. It may contain pathways—even a main pathway with a beginning, end, and checkpoints, but can also contain side paths, alternative routes, or even outright wilderness.

There is an interesting tension here between relatedness and autonomy, because a deep sense of relatedness can in fact be created during one-size-fits-all experiences. For instance, in our Zone program we routinely have all 180 students sit together for one experience or another. This "coming together" with its associated rituals, routines and rules, creates bonding, a shared identity, and common culture. These moments are defined by their very lack of personalization, or individual autonomy. No matter how we feel, or where we're up to, or what our agenda is, in this moment we're going to meet together and operate as one unit.

The concept of a learning landscape allows for such solidarity while providing ample space for personalization, in the form of side paths or a Matrix. These can nurture relatedness, too, of a different sort, as students help each other or cross-pollinate from different pathways.

I mentioned wilderness above. There are parts of landscape that have not been mapped, curated or resourced. They are unknown, even to the teacher, at the outset of the journey and may unfold from moment to moment. Consider the significance of the term "landscape" versus "map." A map is artifice. In contrast the landscape is intractably complex and infinitely fractal. The term "learning landscape" intentionally embraces both of what Yeoman calls "design-in-advance" and "design-in-the-doing" (Yeoman, 2015, pp. 12–13).

Synchronizing Physical, Virtual, and Cultural Space Design

Where do the "digital technologies" referred to by the title of this book fit in the design repertoire that I am exploring? I've already pointed out the similarity between a web portal and our Matrix poster. If cast in terms of information flow these both share a similar function. I wish to pursue this insight through to a main thesis that sees design entirely through the lens of relational affordances between people, space, and information.

Let me start with a strange contradiction: in the early 2000s our school actively pursued a digital technology infrastructure in the form of hardwired computer rooms. These were very popular and in high demand by teachers, especially after we introduced our LMS in 2005. In response to demand, our IT team created more computer rooms. At our peak in 2008 we had 500 desktop computers installed for a school population of about a thousand students.

Typically, the desktops were installed around the perimeter of classrooms, or in a horse-shoe configuration, or both.

We experienced in these configurations a strange contradiction: the technology offered a wealth of new information and interactive possibilities to students, while simultaneously making face to face conversation more difficult by blocking line of sight and restraining physical movement.

The contradiction lead us to conversations about matching the physical characteristics of a space with the technological characteristics of a space. How did they fit together? Or fail to fit together?

Our term for “digital technology” was Information Communication Technology (ICT). Our dilemma was that our ICT design was allowing online information flow, but hampering the flow of information between the people inhabiting the physical space where they were installed.

At about the same time we were experimenting with writing surfaces created by applying whiteboard paint to entire walls or building tables out of old whiteboards, shown in Figs. 15.13 and 15.14.

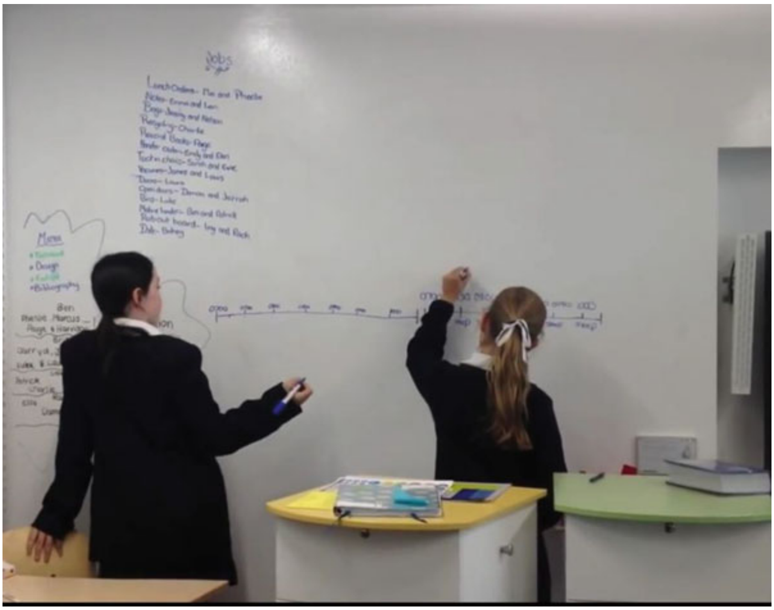


Fig. 15.13 Students work collaboratively on a whiteboard wall

Fig. 15.14 Senior students collaborating on a whiteboard table

Unlike the desktop computers, our whiteboard surfaces were allowing students to contribute their thoughts freely to anyone within line of sight. These, however, did not have the transcendent capacity of a computer to save, duplicate, and transmit information across time and space.

It made sense for use to the term “virtual space” to refer to ***any*** mechanism for the transmission of information. The desktop computers and whiteboard paint were serving the same function: shaping the flow of information. To be strictly consistent in this functional definition—that virtual space is information flow—handwriting, and even vocal cords have to be included.

This definition holds great explanatory power. Consider the popularity of flipped learning videos. A lecture might be ostentatiously interactive, but a flipped learning video can be paused and rewound and fast forwarded. The video essentially separates the information from the living speaker, so that it can have a life of its own. This is how virtual space works: information is unhooked from live communication and becomes a strata in its own right. One need only think of a “keep off the grass” sign or other printed admonition. Whoever created this little bubble of virtual space is now absent, but the sign stands, broadcasting an agenda.

The disruption created by a free economy of information is far from recent. For instance, Socrates expressed annoyance at how freely available knowledge could be obtained by reading. He questioned its value. He complains that readers “will be hearers of many things and will have learned nothing; they will appear to be omniscient and will generally know nothing; they will be tiresome company, having the show of wisdom without the reality.” (Phaedras, *275b*) In his view, knowledge should not come so easy.

The invention of the printing press took the dilemma up a notch: in Ann Blair (2003) quotes Conrad Gesner complaining in 1545 about the “confusing and harmful abundance of books.” Both Socrates and Gessner are coming to terms with an intensifying information ecosystem. The internet is simply continuing the trend.

The practical upshot of this definition is the question: what sorts of information flow do we want to make possible in our learning landscape?

The question can then be answered with a single, unified design that synchronises physical affordances and constraints with virtual affordance and constraints.

Considered from this perspective, our old traditional classrooms were actually very well synchronised: the physical rows of desks faced a front where information would be transmitted from the teacher and the whiteboard. Both layers—the physical and virtual—worked together, albeit in a very constrained way.

Continuing this perspective, in our quest for increased autonomy and relatedness, the desktop computer rooms appear as an awkward and desynchronised middle step with unresolved conflict: the physical design hampered interactivity while the virtual promoted it.

In 2010, we resynchronised our physical and virtual spaces by moving to a "Bring Your Own Device" program. We maintained our enthusiasm for using walls, tables, and windows as writeable surfaces. This allowed information to flow freely in and out of the classroom to the world outside, and within the classroom, and permitted similar freedom of movement through physical space.

We also speak of a third layer of space: cultural space, referring to such elements as routines, permissions, behavioral scripts and norms, and shared values. Just like physical and virtual space, a classroom's cultural space has affordances and constraints and can be shaped by design. Cultural space can synchronise with its siblings or be in conflict with them. During our journey we have worked with intent to shape a set of permissions, routines, and the like to allow students and teachers to feel navigate the higher degrees of autonomy and relatedness that we have established in our physical and virtual spaces.

Caves, Campfires, and Watering Holes

As we sought to find learning designs that synchronised physical and virtual spaces, we were delighted to come across a specific taxonomy of spaces proposed by Professor David Thornburg (2007).

Thornburg proposes the terms "cave," "campfire," and "watering hole" as metaphors that refer to spaces that encourage certain interactions between people and information.

A cave allows someone to relate to their own inner world, a campfire allows a guru to share insights to a group, and a watering hole allows free interaction. I use shorthand to understand these three relationships: 1:self, 1:many, and many:many, but they can also be termed reflection, expertise, and collaboration.

The terms apply elegantly to both physical and virtual spaces. A secluded corner is a physical cave; a blog is a virtual cave. A set of chairs can make a campfire, and so can a flipped learning video. A physical watering hole can be created with grouped tables or agile furniture, or equally in virtual space with a shared Google Doc, an Edmodo social networking site, or indeed any Web 2.0 tool (Fig. 15.15).

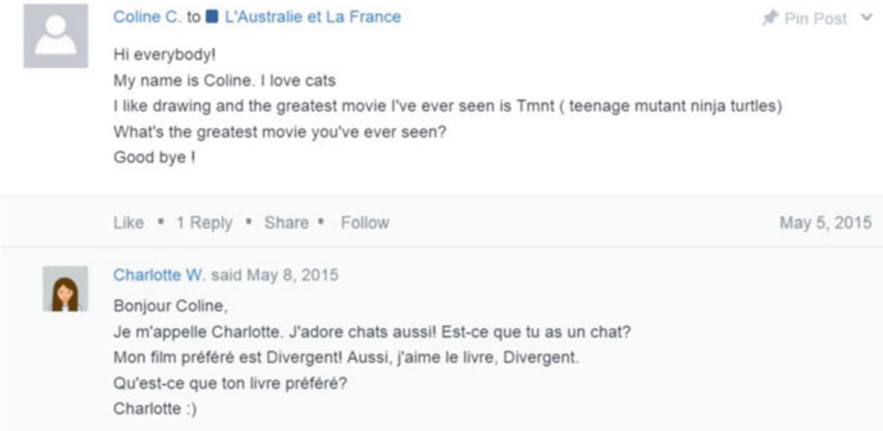


Fig. 15.15 Students from Australia and France communicate using a virtual watering hole: Edmodo

In physical space, the spaces tend to exist in discrete units, but in virtual space some very interesting mash-ups can occur.

For instance, I have referred to a blog as a cave space—it can certainly feel that way to the blogger. However, it can also function as a campfire, sharing thoughts from one to many, and potentially getting the blogger in trouble for their unguarded candor. Twitter can function as a cave, campfire, and watering hole all at once.

Our writeable surfaces—virtual space—share this dual functionality. Students can write reflectively on a wall or table (in a cave space). Then, for as long as the writing remains, their thoughts are accessible by anyone within local line of sight (a campfire) (Fig. 15.16).

In the time-lapse video you can see these different spaces in action. For instance in the video of the Zone program, the child working by himself is in a cave space, while the teacher at the television screen behind is offering a campfire experience, and most other students are interacting in watering hole mode.

The use of our web portal to present and resource various learning activities on a menu of choices is, in these terms, a virtual campfire, as was our original poster showing the Bloom's/Gardner's Matrix.

In a co-teaching environment that includes a laptop program and online videos, students can engage with many varied sources of expertise. One teacher can offer a campfire session in one physical location, while an alternative is offered elsewhere by their colleague, and online explanations are available on tap as the need arises.

Similar opportunities could be replicated even in an environment with few computers and no internet. Flipped learning videos could be made available on the hard drives of the available laptops, or via a DVD on a television screen. Students could walk to one of these stations, by themselves or in groups, and select the video explanation they need.

These sorts of designs don't necessarily need an open physical space either. If co-teaching is desired but the only classrooms available are single cell, a pair of teachers could still work in separate spaces but allow movement by the students, perhaps

	Caves	Campfires	Watering Holes
Relationship	1:self	1:many	many:many
Keyword	reflection	expertise	collaboration
Physical e.g.	sitting separately	furniture arranged with line of sight to 1 person the physical presence of an expert	empty space, agile furniture,
Virtual e.g.	inner monologue, exercise book, slate, diary entry, blog post	single whiteboard or screen textbook flipped learning video information website virtual presence of an expert, e.g. Skype	whiteboard wall or table, or butcher's paper Web 2.0 sites – Twitter, Facebook, Edmodo, Google Docs etc Minecraft
Cultural e.g.	convention of quiet reflection at certain times, e.g. church service	convention to defer to expert, or gather and engage	permission to talk, move, interact

Fig. 15.16 Definition and examples of caves, campfires, and watering holes

establishing a campfire in each space, or a campfire in one and a silent cave space in the other, or a watering hole, or mix. Low-tech virtual watering holes can be created with butcher's paper taped to tables or walls, or by using chalk on concrete floors.

None of these design elements—the learning landscape, linear paths, personalised paths, and caves, campfires, and watering holes make for a necessarily good design. A good design is a design the works according to success criteria. As I lay out at the beginning of the chapter, our criteria were simple and philosophical: we simply wanted all students to be engaged and activated in their learning. We recognised good design with our eyes and ears, seeking out structures that prompted the students to move and talk and contribute. As we embraced these structures we found that ecological language came naturally and intuitively, and helped us make sense of what really mattered in our designs.

Emergent Learning

Emergent learning has been central to our journey for teachers and students alike. For teachers, because we could only develop new designs by trial and error, each prototype opening up new avenues and closing others. For students, since letting go of teacher control meant anything could happen.

When everyone in the room is both individually activated and collaboratively connected, a world of possibility emerges. Learning can happen in powerful and unscripted ways, coming at any moment from the confluence of interactions occurring between people, space, and information.

Counterintuitively, such dynamic learning environments are not devoid of structure, but nurtured through deliberate shaping and resourcing. In particular, digital technologies can find their home within a broader ecosystem that liberates its inhabitants from the tyranny of constant one-to-many delivery or linear cause–effect chains. In our best programs there is just the right combination of structures—physical, virtual, and cultural, to set the scene for the unexpected.

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Chapter 16
Blogging as a Form of Web 2.0 Technologies for Reflective Practice

Gregory Powell

Abstract This chapter provides insights into the use of blogs as digital technology reflective instruments for pre-service teachers. Blogging technologies are described that aim to build knowledge, promote active and engaged learning, independence, and tailor the learning to pre-service teachers for the twenty first century. Through blogging pre-service teachers experience authentic learning critical to modern teaching and learning. Educational understandings are demonstrated as pre-service teachers collaborate and create unique online and offline learning experiences through their use.

Keywords Information and Communication Technologies (ICT) • Web 2.0 • Blogs • Reflective practices • Community of inquiry • Constructing knowledge • Text-based communication • Virtual learning environments • Adoption • Integration • Collaboration • Teachers • Higher education • Pre-service teachers (students training to be teachers) • Professional experience • Digital technology • Reflective instruments • Pre-service teachers • Blogging technologies • Knowledge • Independence • Engaged learning • Active learning • Authentic learning • Teaching and learning • Educational understandings • Collaborate • Create • Online • Offline • Learning experiences • Tools

Rapid Evolution of Web 2.0 Technologies

According to Blessinger and Wankel (2013), four factors have driven the rapid changes in how we teach and learn using such Web 2.0 technologies. The technologies are:

(1) digital, highly versatile and integrative, (2) globally ubiquitous, accessible to anyone and anywhere there is an Internet connection, (3) low cost or free, making them accessible to anyone with mobile devices or computers and (4) the development

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of more sophisticated learning theories greatly increases our understanding of how best to apply these technologies in academic settings (pp. 3 and 4).

The term Web 2.0 was coined by Darcy DiNucci in 1999 in her article titled Fragmented Future "The web we know … is only an embryo of the web to come" (p. 32) but it appears that the term Web 2.0 technologies was also coined by Dale Dougherty, vice-president of O'Reilly Media Inc. "The concept of "Web 2.0" began with a conference brainstorming session between O'Reilly and MediaLive International" (O'Reilly, 2005). Although Rouse (2014) suggests that it was Joe Firmage in 2013, who used the term "Web 2.0 to describe using the World Wide Web as a platform" (http://whatis.techtarget.com/definition/Web-20-or-Web-2).

Regardless of such history associated with the coining of the term, Web 2.0 enables user generated content, sharing of data, and collaboration in new and innovative ways around web-based applications (Anderson, 2007). And as Procter et al. (2010) points out Web 2.0 is, "not just to particular configurations of technology, but also to changing practices of communication and production of information by individuals and groups." (p. 4041).

Social software and the rapid evolution of Web 2.0 technologies over the past 10 years has become increasingly ubiquitous and has altered the way students communicate, learn, collaborate and acquire new knowledge (Campbell, Wang, Hsu, Duffy, & Wolf, 2010; Conole, de Laat, Dillon, & Darby, 2008; Cullen, 2008, and Greenhow, Robilia, & Hughes, 2009). Learning today is "interactive and enabled by the very nature of the internet" (Ramsay & Terras, 2015, p. 383). And Conole and Creanor (2007) report that students "have high expectations of how they should learn, selecting the technologies and learning environments that best meet their needs with a sophisticated understanding of how to manipulate these to their advantage" (p. 11).

Although the uptake by educational institutions over this time has been slow as institutions, like governments worldwide, have not kept pace with policy regarding the implementation and monitoring of Web 2.0 technologies in classrooms (Lemke, Coughlin, Garcia, Reifsneider, & Baas, 2009).

> Mobile technologies and social media, if leveraged appropriately, have the potential to maximize student learning and engagement, and transform the concept of the classroom from four walls to an interactive space where student-centered learning takes place," and "While there are a variety of challenges, there are enormous opportunities, and if we – educators, technology leaders and school decision makers – find ways to harness the power of these tools, the benefits to our young people and our education system are countless. There are also legitimate concerns that must be addressed, but they must be weighed against the potential benefits. (Bales, 2012). http://www.cosn.org/about/news/cosn-and-other-leading-education-groups-release-new-report-aimed-informing-new-digital

The ongoing challenge in the use of Web 2.0 technologies for higher education institutions is the uptake and the ongoing professional learning by academics. As Johnson et al. (2014) states,

> digital fluency of lecturers and professors is a great challenge, although the solutions are clear. Digital media literacy is not nearly pervasive enough in initial education programmes or continuing professional development for faculty. In order for emerging technologies to

be creatively leveraged by students in classrooms across Australia, professors and instructors need to be confident and effective in applying them (p. 3).

Web 2.0 technologies have enabled users to collaborate, share and publish in new and exciting ways and provide for a myriad of interdisciplinary options through an online technical platform available to educational institutions that some authors refer to as “re-evolution” and “democratisation” (De Roure, 2008; Waldrop, 2008).

As Waldrop (2008) states, “the real significance of Web technologies is their potential to move researchers away from an obsessive focus on priority and publication, toward the kind of openness and community that were supposed to be the hallmark of science in the first place.” http://www.scientificamerican.com/article/science-2-point-0-great-new-tool-or-great-risk/

The power of Web 2.0 technologies and in particular blogs (i.e. web log) provide for collaboration and openness for both online and off line communities where information, ideas and questions can be shared. Physical, geographic, economic, political, social and technological barriers are broken down as can be seen worldwide this year in many countries struggling to come to terms with new freedoms and global connectedness.

Through use over many years across a range of curriculum subjects this author contends that using digital Web 2.0 technology such as blogs has range of benefits for education in the twenty first century. Some of the most popular blogs online are: tumblr™, Wordpress™, Blogger™, EduBlogs™, and LiveJournal™, but in reality anyone can design and establish their own blog as part of the success of Web 2.0 technologies.

The benefits for use of blogs within education include:

- Integration with constructivist learning theories
- Learner centred with students in control of their own learning
- Improved information literacy and ICT skills through building and construction of new knowledge
- Increased participation in the learning process through collaboration and practiced learning
- Greater sharing of ideas as users become actively engaged participants in the learning process.

(Hossain & Quinn, 2012)

Issues Associated with Adoption of Web 2.0 Blog Technologies in Education

Apart from the issues associated with the provision of training in the use of Web 2.0 technologies for those professionals teaching in education, the main contentious issues concern trust, security, intellectual property rights, control by educational institutions and the time factors involved in the introduction and ongoing scaffolding of learning. Depending on one's perspective these issues can be seen as barriers or drivers to innovation and adoption in educational institutions.

For the author however, the adoption and use of Web 2.0 technologies such as blogs has been liberating, providing innovative pathways to engage students and provide different modes of assessments instead of the usual academic research essays and examinations (Lim, So, & Tan;, 2010; Mercer, Warwick, Kershner, & Kleine Staarman, 2010; Wegerif, 2007). Sawmiller (2010) states, "online tools such as blogs support collaboration among students and teachers" (p. 46). Blogs provide digital avenues for students to reflect upon their educational practices. The author provides pathways for pre-service teachers to construct individual or collaborative team blogs to capture reflections (i.e. to Post) for professional readings, responses to lectures, workshops/seminars and creation of digital content across a range of curriculum subjects on offer at La Trobe University for undergraduate and post-graduate pre-service teachers. The term to "Post" in a blog means, "An entry written and published to a blog." (https://en.wikipedia.org/wiki/Glossary_of_blogging). Learning in this instance is seen as knowledge construction through participation in reflection (Vygotsky, 1978).

One issue faced by pre-service teachers is to challenge their own attitude about the importance and value of their personal reflections. Too often as new users commence blogging they have difficulty articulating their reflections. Also student perceived behavioural control, influenced by self-efficacy and the availability of resources become important to users (Ajjan & Hartshorne, 2008; Bandura, 1997). Knowledge of and support by university teachers for their students is paramount when using Web 2.0 technologies such as blogs. Usually the author provides a range of free open-source blog software websites and students can also use the University's in-house PebblePad™ system.

Other major issues to be considered when adopting Web 2.0 technologies include:

- higher education institutional ICT support for blog technology especially when problems arise
- establishing testing regimes before approving their use
- the skills required by pre-service teachers to use blog technology
- the debate by some academics and pre-service teachers of the quality and merit of using blogs as forms of assessment instead of the traditional modes of essay writing and testing
- the impact in the use of blogs being peer reviewed by teams of preservice teachers
- the rapid changes in blog innovation as newer versions with more creative tools and functions become available, and
- the provision of professional development for users with time constraints and lack of skills needs to be ongoing (Williams, Stewart, & Slack, 2005).

When using third party blog software other issues to consider for educators are the control and ownership of the blogs themselves as well as online technical support from the providers (many of whom are on different time zones around the world). For example when using Google Blogger Web 2.0 software the terms and conditions of use re Privacy and Copyright Protection state, "Google's privacy policies explain how we treat your personal data and protect your privacy when you use our Services. By using our Services, you agree that Google can use such data in accordance with our privacy policies." (https://www.google.com/intl/en/policies/terms/).

And under Your Content in Our Services, Google states,

> Some of our Services allow you to upload, submit, store, send or receive content. You retain ownership of any intellectual property rights that you hold in that content. In short, what belongs to you stays yours.
>
> When you upload, submit, store, send or receive content to or through our Services, you give Google (and those we work with) a worldwide license to use, host, store, reproduce, modify, create derivative works (such as those resulting from translations, adaptations or other changes we make so that your content works better with our Services), communicate, publish, publicly perform, publicly display and distribute such content.

(https://www.google.com/intl/en/policies/terms/).

Through the use of third party Web 2.0 blog technologies, the content uploaded by pre-service teachers across a range of subjects and courses become visible to the world and hence millions of other users. If blog users don't turn off the blog software options for their Account Settings, Permissions and Post Setting, complete strangers on the World Wide Web (WWW) are able to comment on their reflections; this can be fraught with danger (McLoughlin & Lee, 2007).

However, through use of PebblePad™ such issues are addressed as this software is in-house and has many layers of personal protection for pre-service teachers here at La Trobe University. Users can however elect to publish to the WWW should they wish to share their blogs fulfilling the social centric nature of social media. And such activity is within one's personal control rather than the control of external software companies providing free Web 2.0 blog technologies.

The adoption of blogs as reflective devices to enhance reflective learning enables pre-service teachers to externalise their reasoning through active discourse, be able to justify their beliefs and observations over time, and foster collaboration and social interaction with online audiences (Deng & Yuen, 2009, 2011; Wrede, 2003).

Through trusting students, academics and educators alike aim to develop a blog as a community of practice (Wenger, 2000). It is important to scaffold one's approach when adopting blog technology into educational settings to improve the collaborative process (Pifarre & Kleine Staarman, 2011). This requires regular monitoring of progress by educators to not only maintain a level of interest in the blog but to be mindful of the language used by students when commenting upon other student reflections; and this requires time. At higher education institutions when dealing with large cohorts of students such regular monitoring across numerous subjects and courses takes many hours of extra time. For educational institutions to adopt the use of blogs into daily teaching practices, they must be mindful of providing time for their teachers to monitor the progress of hundreds students (in some instances). Regular check-ins to blog sites throughout semesters by teachers to encourage students as well as to monitor their development of ideas and language must be allocated to individual teacher workloads. The acceptance by teachers of Web 2.0 technologies is vital for the twenty-first century and is reliant upon how such technologies being linked to their current practices (Lee & Winzenried, 2009).

Explicit Uses of Blogs

Technology is an ever present reality in the lives of students and for some the level of application is quite sophisticated. The use of blogs, wikis, Twitter, Facebook, texting and many other technologies provides for formal and informal levels of collaboration. Students in today's educational institutions are very different from those of previous decades because the use of technology is altering not only their learning styles, but also their strengths and preferences (Dede, 2007; Shapley et al., 2011; Smolin & Lawless, 2007).

A number of researchers have explored Web 2.0 technologies and in particular social networking technologies (blogs, Wikis, Facebook, Twitter etc.), highlighting the creative, interactive and engaging learning experiences offered through their use (Antonio & Tuffley, 2014; Park, 2013). Pre-service teachers and students alike can become "producers as well as consumers" of such technologies (Park, 2013, p. 49). According to Manochehri and Sharif (2010) when technology is used to facilitate self-directed learning, "Effective technology integration is achieved when the use of technology is routine and transparent and when technology supports course objectives" (p. 35). So for educators it is wise to incorporate into the classroom the tools and technologies that students are already using in their everyday lives.

However the use of such technologies regardless of sophistication does not guarantee engagement by learners. The alignment of pedagogy, content knowledge and technical knowledge provide the foundations for integrated, creative and innovative uses within educational settings.

In the author's opinion blogs can provide for more meaningful and personalised learning, can foster critical and higher order thinking skills, the development of online and global communities enabling interaction and interconnectedness, and authentic real-world learning opportunities enabling collaboration through building a sense of belonging by users (Lave & Wenger, 1991; Ramsay & Terras, 2015; Vygotsky, 1978). Importantly, reflective blogging is cyclical: reviewing, reflecting, revising, and evaluating. The success of utilising reflective blogs in one's teaching requires having clear and transparent learning goals and expectations, detailed instructions, relevance to the subject or course, providing assessment rubrics and making sure that the digital environment is safe.

Subject areas where La Trobe University utilises reflective blogs in both undergraduate and postgraduate pre-service training programmes incorporate design technologies, ICT subjects, multimedia, science, curriculum, assessment and reporting subjects, classroom management and school placements/professional experience. An example of video use associated with a science experiment can be found on Vimeo™ by Wardlaw (2013) at https://vimeo.com/40807341. Other tasks requiring reflection include issues associated with school placements such as, classroom management, classroom structures for delivery of literacy and numeracy lessons, and resources used across a range of curricula. These are expressed as a series of trigger questions, to prompt pre-service teachers in their observations when in schools. However academics are aware of the context around reflective blog writing whilst pre-service teachers are on professional experience being influenced by the supervising or mentor teacher as well as the teaching context itself. This is supported by Boud and Walker (1998) who argue that, "Context is perhaps the single most important influence on reflection and learning. It can permit or inhibit working with learners' experience" (p. 196).

Explicit Uses of Reflective Blogs

Empowers Users Through Personalised Learning

According to Thomas and Velthouse (1990), there are four dimensions to empowerment: meaningfulness, competence, impact and choice. As Park (2013) states about Cobanoglu and Berezina's (2011) research, "students in a hospitality course showed an enhanced engagement with their reflective paper assignments when they posted them in their blog, as compared to those instances in which they typed them in papers" (p. 49). The author of this chapter provides opportunities for pre-service teachers to develop confidence based upon individual choices of set assessment task(s) when asked to reflect on various software applications for use in classrooms. These pre-service teachers are presented with a huge range of Web 2.0 technologies and after their Sandbox experiences (i.e. "playtime") in using the software are asked to reflect within their blogs upon the functionality, ease of use, benefits of use and how to apply such Web 2.0 technologies in curriculum and lessons within educational settings. The impact of such practice is that the pre-service teachers are empowered through individual choice to reflect at a personal level rather than just stating what the software companies see as educational benefits through the use of their products. Feedback to blog users can be immediate from both peers and academics/teachers apart from comments by a global audience should the blog be published to the Internet.

Enables Collaboration

Wood and Gray (1991) defined collaboration as, "a process in which a group of autonomous stakeholders of an issue domain engage in an interactive process, using shared rules, norms, and structures to act or decide on issues related to that domain" (p. 437). Blogs can be set for use by individuals, pairs or even teams. If set at the individual level other users within the subject or course can post comments on what has been written and a weblog trail of comments is established. If set for pairs or teams, then the real collaborative nature of Web 2.0 blog technology comes to forefront. The author's University promotes blended and online learning as a mix of face-to-face and online learning for students. Collaboration helps participants, "make use of each other's talents to do what they either could not have done at all or as well alone" (Wildavsky, 1986, p. 237). Opportunities exist for students using blogs to collaborate on projects and interact with each other, the resources provided and the teacher concerned with the subject or course. Communities of practice become established within subjects or courses and as Kanter (1994), Arino and Torre (1998) report, such relationships and networks are extremely important to the development of collaborative partnerships requiring trust and the development of informal interpersonal relationships and connections to improve learning and understandings to develop for users.

Promoting collaboration may be easy but it can be difficult to implement as many of the users may not be familiar with or have had experience in using collaborative software (Johnston, 1997). Scaffolding of the learning process to develop trust and relationship building for using blog technology is required by academics and teachers alike. Some individual pre-service teachers lack the interpersonal skills that allow them to work well in groups or on teams despite the fact that teachers in schools today plan and work in collaborative teams. As the Victorian Department of Education and Training (DE&T) state, "whole-of-practice approach promotes and supports high levels of professionalism and excellence in schools and allows teachers, principals, school staff, parents and students to work together to make sure Victoria's education system is one of the best in the world" (http://www.education.vic.gov.au/school/teachers/profdev/Pages/performancedevelopment.aspx). Strict ethical protocols need to be established to support all users of blogs to encourage participation and make users aware that views expressed by members of teams may differ and that "healthy" debate and the posting of comments different from others is acceptable. Protocols enable pre-service teachers to have meaningful, sustained online blog conversations about teaching and learning without getting derailed by personal side issues. Rather than protocols stifling "conversation" the author argues that their use leads to more meaningful and respectful feedback dialogue between users of blogs.

One of the most pressing concerns for members of teams using blogs relates to every participant being prepared to submit posts and continue to support their team members rather than just leaving the bulk of the work requirements to a few. Again the author places strict protocols on teamwork and the importance of sharing among members of each blog team. For example, each member of each blog team is required to formally post their contribution to the set task for the subject or course. In this way publicly posting such discussion online enables everyone in the pre-service teacher cohort to read everyone else's contributions to the set task. Once these protocols have been established and applied, the responsibility lies with all users to abide by the agreed code of behaviour.

Fosters the Further Development of Literacy Skills

In her book, Radical Reflections (1993), children's author, Mem Fox, states that, "You and I don't engage in meaningless writing exercises in real life—we're far too busy doing the real thing. And by doing the real thing we constantly learn how to do the real thing better." (p. 4). Literacy in the twenty first century is about shifting ideas shaped by today's social and cultural practices that are associated with literacy, new learnings and new media. As Brown (2008) states, "Web 2.0, is creating a new kind of participatory medium that is ideal for encouraging multiple types of learning" that not only fosters learning about subject matter but also encourages young people's "social learning" and "understandings" of their learning as participants in a community of practice (http://chronicle.com/article/How-to-Connect-Technology-and/19100). Although much has been written about digital natives and their uptake of technology (Prensky, 2001), the digital fluency by many twenty first century students is recreational and not educational. And so it is when students are writing their reflective blogs, the author embeds literacy practices into subjects and courses based upon academic readings, seminar/workshop activities and lectures delivered. Students are required to summarise what has been delivered in the seminars and hands-on workshops, then reflect upon both the content and the application for education generally and the pros and cons for use within classroom settings specifically. As the author has observed over many years what becomes quite noticeable when examining pre-service blogs: that the more they write the better their writing skills become.

Student A: *Reflecting on a pre-school family member using technology and the issues raised in Roger Schanks article*: *Active Learning Through Multimedia*:

> Sally said she had never actually shown Harry how to use the iPad and had never played games on it. Harry's older brother and sister however, did play games on the iPad. I asked them if they had ever shown Harry how to play the games to which they responded they hadn't. Interestingly, when asked about the game Harry was playing, neither had played it before. I found this incredible. This supports Roger C. Schanks article 'Active Learning through Multimedia'. Although not educational software, Harry managed to switch on and successfully navigate his way around this technology on his own simply by observing another's skills and make sense of and apply what he'd seen. The impressive part is that he displayed the behaviour discussed in the article perfectly.
>
> After seeing this, I reflected on just how powerful good, appropriate interactive technology is, or could be for all learners. Multimedia like the one discussed in the article 'Road Trip' can have amazing results, both directly and indirectly. Good, interactive technology with appropriate content and immediate learner feedback is a significant part of success in 21st century learning.

As Stiler and Philleo (2003) report blog, "entries were longer and written in ways that indicated that students were considering the bases and motivations behind their beliefs rather than just merely describing them" (p. 795).

Fosters Critical and Higher Order Thinking Skills

Brookhart (2010) reports that higher-order thinking falls into three categories in terms of: (1) transfer, (2) critical thinking, and (3) problem solving. As Anderson, Krathwohl et al. (2001) argue the most important educational goals are to promote both the retention of information and skills (i.e. recall) and the transfer of such information to new and meaningful learning (i.e. higher-order thinking). As Bloom's and Anderson's taxonomies are studied in a variety of core subjects and course for pre-service teachers, promoting higher-order thinking skills such as analysing and evaluating information gathered within workshops and seminars has become second nature for many education students when writing reflectively in their blogs across a range of topics and curricula. Questions like: How could the use of the software Inspiration™ be used across the curriculum to develop higher-order thinking skills in school students? And, why would classroom students use mind mapping software instead of concept mapping software when answering a posed question that requires individual or group investigation? The use of specific vocabulary within blog postings provides evidence for the author that the pre-service teachers are using the language of higher-order thinking. Such terms as "recall, label, examine, define" all suggest that the blog author is demonstrating their knowledge of content. And the use of terms such as "predict, experiment and solve" suggests that they are applying higher-order thinking, whereas terms such as "decide, criticise, judge" suggest that the pre-service teachers are evaluating their practices (Anderson et al., 2001).

Within the pre-service teachers blogs opportunities exist for personal reflection based upon scientific experiments, hands-on materials, information or systems workshops in design technologies and overall ICT use in classrooms. Through practice in reflective writing in their blogs the pre-service teachers begin to understand the critical features of higher-order thinking skills and the application of such to everyday classroom situations. According to Williams and Jacobs (2004), the actual process of creating blogs and posting reflections encourages students to become more critically analytical in their thinking and this an important pedagogical element for the next generation of teachers to acquire.

Provides an Online Portal for Authentic Audience Participation

Research shows that learners today use online social networks to, "fulfill essential social learning functions … peer support from current and former classmates, and targeted help with school-related tasks" (Greenhow & Robelia, 2009, p. 1153). Through using Web 2.0 blog technology the author immerses pre-service teachers in authentic educational issues and activities to investigate. Users have a choice as to which issue they want to research and write about through posting reflections online.

For example, the Masters of Education students in a multimedia subject at the author's university are presented with a range of current, topical and controversial issues associated with the use of technology in society today. Such issues include: the digital divide, sexting, protection of students online, social media, viruses and hacking, and information literacy. A range of academic research journals and websites are provided as a starting point for these students. Through the use of their blog individuals post messages to each other and divide the research into categories to be studied. Once each group has aligned their thoughts, they work through just how they would present their findings in a multimedia presentation. Some pre-service teachers decide to use MS PowerPoint™, GoAnimate™, Prezi™, Keynote™, etc., or even make their own videos with individual members participating in each section of the presentation. They are required to research in teams the issue in question, the impact upon students, teachers and schools and provide educational solutions. The final showcase of the pre-service teachers' research is presented in a multimedia format and is peer assessed using an assessment Rubric. The four criteria are: issue explored, demonstration of suitability of multimedia resources used in presentation, inclusion of additional educational ICT activities to support the learning and summary of their multimedia presentation. Each criterion is ranked from comprehensive through to unclear. The rubric is known by all students at the commencement of the subject and marks are awarded for each criterion addressed.

The pre-service teachers not only learn about using the blog software in a collaborative environment but also investigate authentic real-world issues in a peer-based online ICT portal. Through the provision of blogging, the participants learn new software techniques and ICT skills and understandings associated with peer observations and at times have to defend their views whilst participating in a community of practice.

Develops a Sense of Community and Interconnectedness

Through participation in blogging, students are supported by a virtual network based on social connectivity that many use in their daily lives outside of academia or schools. Learning for pre-service teachers is a situated activity where users participate in a network of scholarly endeavours (Lave & Wenger, 1991; Lave & Wenger 1998). Interpersonal connections are made across a range of social networks through blogging as users post comments to others about using other social networking sites or even other Web 2.0 technologies they current use as well as commenting upon the subject or course research requirements (Meyer & McNeal, 2011). Learning in this context is more than the acquisition of a body of knowledge, rather it is being a participant in socio-cultural educational practices of scholarship through shared social interaction across a network of like-minded users and in some instances multiple audiences. The rich interactions between participants provide for active management of content, the ability to communicate through a range of multimedia attachments that fosters learner connections accommodating for a community of shared practices (Liang, 2007).

The following Fig. 16.1 demonstrates the template pre-service students use to develop their reflective blog (ePortfolio) based upon observations when in schools on Professional Experience over a number of weeks. There are targeted Literacy and Numeracy trigger questions to aid pre-service teachers in their reflective writing as well as directing their observations based upon classroom management, planning and instructional strategies used in classrooms they had observed, authentic tasks

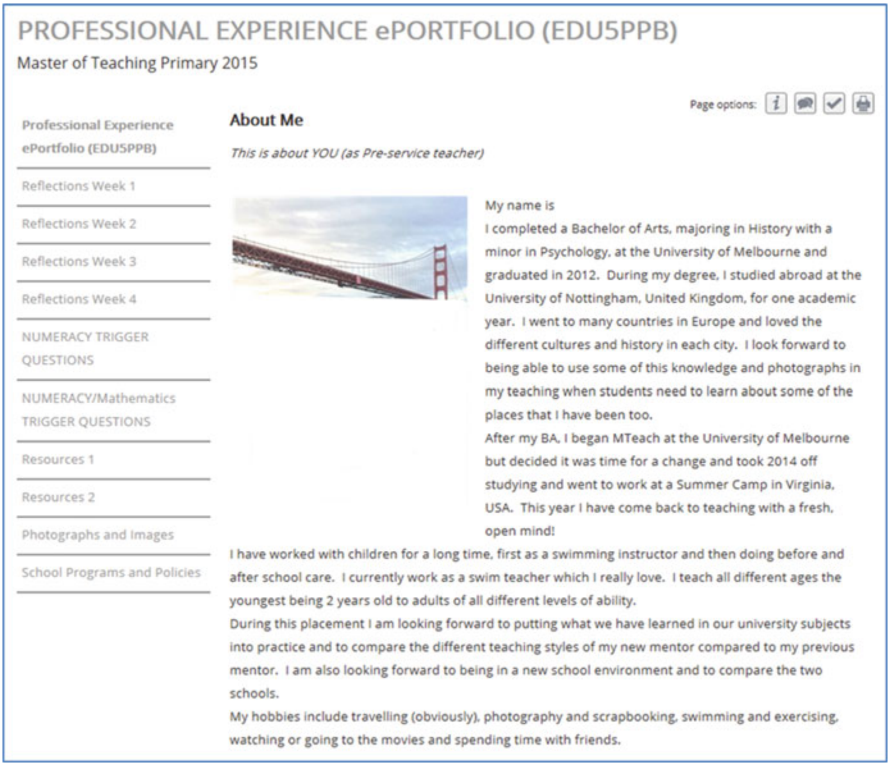

Fig. 16.1 ePortfolio—Weblog Menu—About Me section (Reflective Practices when in schools as part of Professional experience for pre-service teachers)

used to develop higher-order thinking, classroom setup and literacy and numeracy resources used etc. Other menu items that are used include a section called About Me (where they place a picture of themselves and write approximately 100 words about themselves), as well as an Educational Philosophy section, and other sections for them to store photographs of work created by students in school, or even lesson plans and additional educational resources of value such as PDFs, Policy documents and websites.

Through these menu items pre-service teachers share information relevant to the whole cohort of students studying the same subject or course. Like any cohort of students worldwide there are differences among the learners' English writing proficiency, the level of ICT skills, and their motivation. Linking this ePortfolio blog to assessment tasks within subjects has proven to impact more on each students' learning and participation. By recording professional learning "events and experiences at, or close to, the time they happened it is easier to build an authentic record which allows learners to look back and see what they have learned, how they have changed and how they have developed. The narratives that a learner constructs later can then explain how the events relate to each other over time rather than just their moment by moment significance." (http://archive.pebblepad.com.au/pebblegogyconf/sample/Pebblegogy_chapter_03.pdf p. 17). The process of submitting ideas and creating blog posts appears to encourage students to become more critically analytical in their thinking (e.g. Williams & Jacobs, 2004).

Provides for Global Connections to Real World Learning Opportunities

As the rapid growth in technology and collaborative teamwork across most businesses and cultures is at the heart of the global economy today, pre-service teachers and students alike need to be exposed to such worldwide collaboration processes. According to (Meinecke, Smith, & Lehmann-Willenbrock, 2013) the "intercultural use of blogs, then, adds another dimension to the classroom by encouraging students to think about how they are saying things—not just to get their point across, but to reach an audience whose language, values, and cultural context may differ" (p. 429).

Through blogging pre-service teachers are exposed to a range of global partners they can link to through technology. Users can reach out, connect and collaborate with a range of educators, classrooms, experts and students from around the world via blogs as well as other technologies such as Skype™ and video conferencing. The ePALs (Cricket Media™) website provides opportunities for students and educators to become involved on the global stage with students, schools and educators from over 200 countries collaborating across many subject areas of the curriculum. Providing opportunities for pre-service teachers to explore the use of ePALs and other similar websites (e.g. iEARN™, GlobalSchoolsNet™, Classroom 2.0™, Edmodo™, just to name a few) within inquiry based subjects and courses enables a broadening of their global understandings across cultures. Empowering the next generation of teachers to work locally but think globally through using blogs provides a powerful learning tool to the global education system represented across the boundaries of space and time (Fullan & Langworthy, 2013). Innovative ideas, practices and creative online spaces provided and shared by educators and students alike offer twenty first century challenges to pre-service teachers through such exposure.

Through online blogging users are exposed to millions of users and for those of us involved in education, exposure to a range of classrooms, ideas, technologies, and ICT events. A Korean Internet Security Agency survey of internet usage indicated that four in five social media users access blogs with 89 % of those users being in their twenties (KISA, 2010). Many of this age group are studying at higher education institutions and are willing to utilise such technologies. As academics it is in our best interests to capture the enthusiasm, skills and interest for such use by these groups to better engage and further provide links to global, real-world connections based in education.

Fosters Further ICT Skill Development

In 2001, Marc Prensky published his controversial article titled, “Digital Natives, Digital Immigrants” to much acclaim as well as some controversy. However the author of this chapter has for many years (including 2015) worked with pre-service teachers in academia that have inadequate ICT skills (although reasonable ICT recreational skills) and little regard for the use of social media and blogging in education. So it becomes important to upskill such individuals in not only the benefits of such Web 2.0 technology use in education but the actual ICT skill sets required when using such technologies. This can be a demanding exercise considering there are time constraints within subjects and courses on offer at higher education institutions. Scaffolding and sometimes individual attention by academics are required to support the students and improve their ICT skills in the first instance. Secondly it is imperative that the benefits accrued through using Web 2.0 technologies in education are highlighted, practised and embedded into subjects and courses. For many pre-service teachers, the writing, resourcing, timing and delivery of lessons to students under their care when on Professional Experience rounds in schools are all encompassing. The author of this chapter has on many occasions turned “non-believers” around to “believers” through carefully crafting the practical implications for the delivery of lessons utilising Web 2.0 technologies such as blogs. It is the author’s opinion that once ICT confidence has developed through their own personal practice in utilising a range of software and websites, pre-service teachers are more prepared to embed the use of Web 2.0 technologies into daily classroom lessons.

As confidence and success in the use of blogs is improved, new ICT skills, such as how to build and navigate websites, the archiving and retrieving of information, are learned, allowing not only for knowledge exchange but innovation and creativity in expressing such use. For example, bloggers learn ICT skills to personalise and customise their blogs with background images and personal banner photographs and learn to navigate and manage using learning management systems and specialised software packages such as PebblePad™. Video clips, hyperlinks, avatars and voice/sound files can be added to support their writing reflections and this can be seen to develop once personal confidence and ICT skills are improved (Bausch, Haughey, & Hourihan, 2002).

Through such personalised learning pre-service teachers come to appreciate the learning involved and how they themselves can scaffold such learning for their own students in schools.

Provides a Forum for Learning About Appropriate Online Behaviours and Expectations

According to Fullan and Langworthy (2013) the deep learning skills required for education and learning to prepare all learners “to be life-long, connected and collaborative problem solvers and to be healthy, happy individuals who contribute to the common good in today's globally interdependent word" (p. 2) are: character education, citizenship, communication, critical thinking and problem solving, collaboration, creativity and imagination (Fullan, and Langworthy 2013, p. 3). Through using blogs pre-service teachers learn about appropriate online behaviours, citizenship (i.e. concerned for and being sensitive and respectful for the needs of others and other cultures), and the development of global knowledge and involvement in addressing many of the issues facing humankind today (i.e. environmental and sustainability concerns). So through the use of blogs pre-service teachers become aware of their postings being available in the public domain and hence could be exposed to online abuse (unless working within closed blog systems like PebblePad™), the importance of spelling and grammar for teachers especially, and the connected and social nature of the learning within these forums. As technology today provides users with the ability to respond immediately in the online environment, exposure to risks such as cyberbullying, trolling, flaming (repeatedly leaving negative messages), harassment, exclusions from groups or teams, grooming, fake profiles, sexting, cyberstalking, contact with illegal or offensive material have become common. Governments and educational institutions globally have responded and provided online support and clear guidelines for users (and here in Australia: eSafety: https://esafety.gov.au/, ThinkUKnow: http://www.thinkuknow.org.au/, Bullying. No way! www.bullyingnoway.gov.au, KidsHelpline: https://www.kidshelpline.com.au/kids/get-help/web-counselling/, StaySmartOnline: https://www.communications.gov.au/what-we-do/internet/stay-smart-online, the Alannah and Madeline Foundation: http://www.amf.org.au/ and Lifeline—phone within Australia: 13 11 14). The ThinkUKnow 2014–2015 Corporate Report states that: "20 % of young people have been exposed to cyberbullying within the past year" (Australian Federal Police, 2014–2015, p. 9).

In the opinion of the author the onus is upon teachers to be proactive and teach students about such inherent dangers and to provide the necessary eSafety tools to combat and protect against such negative online behaviours. Pre-service teachers are provided with the latest eSafety websites and information and through lectures, academic readings and their blogs these students are required to discuss aspects of using technology today in their reflective responses. There is ample discussion about how current schools implement eSafety practices and scenarios are discussed in workshops and reflected upon by pre-service teachers here at La Trobe University. DE&T has for many decades provided templates to school communities for what are referred to as Acceptable Use Policy for ICT Systems. Essentially these are DE&T Policy documents that ensure all ICT resources are used appropriately and professionally at all times (http://www.education.vic.gov.au/Documents/school/principals/infrastructure/ictacceptableusepolicy.pdf).

Through this process it is hoped that as the pre-service teachers enter the teaching profession as fully qualified teachers, they in turn will be proactive in their teaching and implement workshops and curriculum to incorporate appropriate online behaviours and student expectations when using technology.

Fosters a Growing Confidence in Reflective Writing

As Downes (2005) contends, Web 2.0 is an, "attitude not a technology" (p. 10). It is collaborative in that it is learner and community based, its instructional functions enable both content development and the collation of new knowledge. Over many years of use with pre-service teachers the author reports that as they continue to write reflectively through using blogs they become more "digitally fluent" as their ICT skills and understandings of particular technologies improves. Reflective writing enables users to recognise the connections between what they already know or experienced and what they are in the process of learning. Thinking deeply and writing about a learning experience involves describing, analysing, evaluating the experience leading to self-knowledge (Brandt, 2008; Dewey, 1933; Sockman & Sharma, 2008). Critically reflecting on experiences through blog writing allows pre-service teachers to develop deeper understandings of themselves.

Student B: *Blog Reflections based on PowToons*™ *introduction in workshop*:

> To create my Powtoon I needed to transfer my knowledge of digital literacies from previous experiences to problem solve and manipulate the program. Simple skills of drag & drop, text formatting, using menus, adding slides, capturing (thanks to Jing) and uploading images were essential. Researching the subject meant I needed to know where and how to retrieve information. Downloading articles to my iPad for reading and annotating is a skill I have been using for some time.
>
> Some techniques that needed to be implemented that were new to me were due to the limitations of some of the tools available within this program. Understanding and using a timeline (problem solving only 20 seconds per slide) with the intricacies required in this program was new to me, but not difficult. Sound was my challenge. Powtoon only allows two audio files to be imported - one for music and the other for voice. I wanted my voice recording to match the slides and sometimes specific images or text. The voice recorder available to me within the program didn't allow me to view the slides whilst recording and would mean I would need to record for the length of the presentation in one recording (talk about a challenge).
>
> To problem solve this I decided to use GarageBand on the iPad. I have had limited experience with the desktop version and no experience with the iPad app. I recorded audio for each slide individually and then needed to get the timeline in sync with the visual presentation which was challenging, but came together quite quickly. I then had to export this file and upload it to Powtoon along with the music. Balancing the audio of the two tracks was quite a simple feature of the program. Once the audio file was imported, I had to manipulate some visual items to better align them to the audio track.
>
> My final challenge was to create a YouTube account and upload the video to YouTube. I'm not keen on sharing items online (I typically keep my digital fingerprint to a minimum) so needed to restrict the privacy settings so the video is not publicly available.
>
> All in all it was great to challenge myself using a program I had not even heard of a month ago. The digital literacy knowledge I have held me in good stead when problem solving Powtoon. I feel that digital literacy, whereby learners are able to transfer skills between devices, programs and hardware, is essential for all 21st century learners (Barbary, 2014).

But such deep learning doesn't come naturally for many pre-service teachers and so opportunities need to be provided and nurtured within the subjects and courses within academia. Pre-service teachers need time to develop their ICT skills and reflective writing to improve their online voice (i.e. blog reflections). The sharing, commenting, exposure to other views as well as the use of the Web 2.0 technology all impact upon levels of confidence in the first instance. As Lester and Mayher (1987) contend, "To be a professional is not to have all the answers. Rather, a professional is someone who can reflect on tentative solutions, collaborate with others on the possible avenues available, and risk making mistakes because mistakes are an inevitable part of building new roads" (p. 209).

Summary

This chapter provides insights into the use of blogs as a Web 2.0 digital reflective instrument for pre-service teachers. The author discusses the major issues confronting the introduction of blogs into modern education and argues that through their use blogs build knowledge, promote active and engaged learning and assist with the development of independence in pre-service teachers. The author designs learning experiences across many subjects and courses for pre-service teachers to utilise at University with the expectation that as they enter the teaching profession they too will introduce Web 2.0 technologies into daily classroom practices. Blogging provides pre-service teachers with twenty-first century authentic learning experiences for reflecting upon their practice and building their digital literacy capabilities.

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Chapter 17
Digital Learning in Canadian K-12 Schools: A Review of Critical Issues, Policy, and Practice

Paul W. Bennett

Abstract Digital learning is on the rise in Canada and now exerting an impact upon education policy in most of the nation's ten provinces and three territories. Without a national education department, the promotion of twenty-first century skills, technology, and learning falls to provincial and territorial education authorities with varying degrees of commitment to K-12 technology education reform and classroom integration. National advocacy groups such as C21 Canada do hold sway over provincial ministers of education, but, so far, the implementation of twenty-first century learning and the explicit teaching of "digital literacies" is very uneven, particularly outside of the recognised eLearning leaders among the provinces, Ontario, British Columbia, and Alberta. In spite of the tremendous potential for expansion of online learning and virtual schooling, the free market remains regulated and private providers are largely absent. Provincial or school district authorities promote a "growth-management" strategy where online and blended learning are considered the next evolution of effective technology integration.

Keywords Distance education • Blended learning • Disruptive innovation • Managed growth • Digital literacies • C21 Canada • K-12 Schools • Policy and practice • Digital learning • Education policy • Twenty-first century skills • Technology and learning • Advocacy groups • eLearning leaders • Virtual education • Free market • Private providers • School district authorities • Growth management • Hybrid model • Technology integration

Text

Technology may be transforming the everyday life of Canadians and particularly the younger generation, but the implementation and growth of digital learning remains uneven in Kindergarten to Grade 12 (K-12) schools across the Canadian nation. Over the past decade, online resources, such as e-learning courses and programs as well as virtual schools, have either spread or popped up in Canada's remarkably

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diverse provinces and territories (Barbour, 2008; Barbour & LaBonte, 2014). At the elementary and secondary school level (K-12), regular "brick-and-mortar" schools have acquired computer hardware and software, connected them to the Internet, installed wireless networks, and offered in-service training in Information Communication Technologies (ICT) to both novice and experienced teachers. Across Canada, from Newfoundland and Labrador to British Columbia, the infrastructure in most schools now enables Internet access, student portals, digital libraries, and networks that support laptops, handheld and other portable devices (Plante & Beattie, 2004; CCL/Mills, 2009) . Among Canadian educational authorities and teachers, there is a growing realization that "digital literacies" are becoming essential in preparing students for full participation in the emerging post-industrial "knowledge society" of the twenty-first century (Chen, Gallagher-Mackay, & Kidder, 2014).

The first generation of ICT for the classroom was, as Larry Cuban aptly noted, "oversold and underused" in North American schools (Cuban, 2003; Jensen, Taylor, & Fisher, 2010). Today's Canadian students are far more "cyber-savvy" and hungering for more sanctioned opportunities to use technology inside the schools. Popular books like Don Tapscott's *Growing Up Digital* (Tapscott, 1997) and others with titles like *Millennials Rising* (Howe & Strauss, 2000) went so far as to suggest that the "Net Generation" (born to Baby Boomers) and the Millennials (most of today's students) had turned the "generation gap" into a "generation lap" when it came to the mastery of technology. Such broad generalizations about the generational differences may well be exaggerated and, as the University of Georgia's Tom Reeves has shown, the technical fluency and knowledge of today's students runs far broader than it does deep (Reeves, 2008). The new generation of learners may now inhabit a "digital world" but they are also hobbled by a strain of "selfie-ism" and dogged by the legacy of "parental perfectionism." Introducing technology alone in schools has not proven enough without active teacher support and engaged, motivated students (Barbour, 2009).

Mobile learning technology has been adopted almost en masse by the "Net Generation" and by today's so-called "screenagers." While the innovative use of online technologies has gradually penetrated into the publicly funded school system over the past 10 years, the availability of, and access to, these technologies has not kept pace with student demand or expectations. Some schools right across Canada still remain "locked-down" to the free use of such devices outside of designated rooms or access points (Hutchinson, Tin, & Cao, 2008). A recent Ontario study (Jensen et al., 2010) identified the "ongoing but under-reported disconnect between the massive spending devoted to digital technologies in schools, and their persistent under-use in classrooms, despite claims that the 'next gen' of tech-savvy educators are more inclined to integrate technology into their teaching" (p. 5). "Some of the underuse of ICT is related to a continuing gap in the systematic implementation of technology integration, both in faculty of education training and in ongoing professional development. Even if classroom teachers are sufficiently prepared, a 2014 Ontario People for Education report found that they face 'significant barriers to integrate ICT,' including curricular shortcomings, constraints around access, lack of technical support and limited preparation time" (Chen et al., 2014; Hixon & Buckenmeyer, 2009).

Current State of K-12 Online Learning

Annual reports on K-12 Online Learning from 2008 to 2015, mostly researched and written by Canadian information technology expert Michael K. Barbour, demonstrate steady and incremental growth in the practice of distance, online and blended learning. Without a national education authority and public education governed by the provinces and territories, accurately assessing that growth in a country with 5.3 million K-12 students and 15,000 schools remains challenging for researchers. Based upon increasingly reliable annual surveys, the numbers of tracked "distance education students" have risen from some 140,000 (0.5 %) in 2008–2009 to 332,077 (6.2 %) in 2013–2014 (Barbour & LaBonte, 2014). The use of blended learning is on the rise, even if the reported data is rather patchy. With the 2012 formation of the CAN eLearning Network, a national pan-Canadian consortium focused on K-12 online and blended learning, better data may be generated, making tracking much more accurate and reliable for policy analysis and decision-making (Barbour, 2013; CAN eLearning Network, 2012).

Compared with the recent dramatic expansion of digital learning in the USA, online and blended learning in Canada's K-12 public schools has followed a decidedly different pattern of evolution (Finn & Fairchild, 2012; Barbour, 2012). Much of the online learning in parts of Canada remains an outgrowth of correspondence school education, involving e-format programmed units, audio distance learning, and video conferencing. The primary drivers in Canadian provincial and territorial systems are government authorities, while learning corporations serve as contractors providing content, learning technologies, and support services to the government-run operations. In spite of the tremendous potential for expansion in online learning programs, the free market remains regulated and private providers are largely absent. Provincial or school district authorities promote a "growth-management" strategy where online and blended learning are considered the next evolution of effective technology integration (Barbour SITE, 2015) (Fig. 17.1).

"Twenty-first century skills, technology, and learning" is a common phrase used by Canadian education policy-makers and the popular media to signal, first and foremost, change, defined in terms of meeting the needs of the "next generation" of learners. A national organization, *C21 Canada*, emerged in 2011–2012, to promote "new models of public education" in response to "the advent of the knowledge and digital era." In May 2012, C21 Canada released a futuristic blueprint, *Shifting Minds*, proposing "a go-forward 21st Century learning framework for Canada's public education systems" founded upon a set of seven declaratory principles, endorsing freer access for students, more "personalized" learning, and pledging support for "educational leaders" committed to digital learning initiatives (C21 Canada, 2012). While the C21 Canada policy paper purported to be "Canadian" in origin, it mirrored the American Partnership for 21st Century Skills (P21) approach and was buttressed with mostly US technology-in-education research studies (C21 Canada, 2012, Appendix). Working with the Council of Ministers of Education Canada (CMEC) and Canadian branches of the international learning corporations,

Fig. 17.1 The 21st Century Learning framework, proposed by C21 Canada in 2012 (Reproduced from C21 Canada, "Shifting Minds: A 21st Century Vision for Public Education for Canada," 2012).

C21 Canada holds regional conferences and attempts to "seed" twenty-first century learning, mainly through provincial and territorial departments of education (C21 Canada, 2015). In British Columbia, the BC Learns initiative, first proposed in late 2010, and known as "Personalized Learning," won the support of C21 Canada and, in 2015–2016, is being piloted in 16 different elementary schools (British Columbia, 2015). Ontario's eLearning initiative from 2011 to 2014 drew, in part, on C21 Canada's work (Ontario Education, 2011). In other provinces, such as Nova Scotia, the twenty-first century learning promoters have secured some regional school board support, but gained little traction with budget-conscious provincial education departments (Nova Scotia, 2015).

More recently, Google Apps for Education (GAFE) has begun to make inroads in Canada's K-12 school systems. When it comes to digital learning, Google has enjoyed much more success than Microsoft and smaller players in the growing market for software in elementary and secondary schools. First introduced in 2006, GAFE made its first big breakthroughs from 2012 onwards. Public concerns that Google was mining student e-mail accounts for ad targeting purposes represented a setback, but that problem was squarely addressed in April 2014. In the case of one Canadian province, Nova Scotia, GAFE was adopted, piloted during 2014–2015, and then approved for a rollout to all 400 public schools in the province (Julian, 2015). By the end of 2015, it was spreading quickly and teacher training summits had been held or were scheduled to be held in Ontario, Alberta, Quebec, and BC, as well as Nova Scotia. In schools across the country, it is becoming increasingly essential for students to have access to the Internet in order to be successful. Homework, projects, even information and advice from teachers was now transmitted on-line, and more readily accessible if you had the electronic tools to access the information (Frost, 2015).

A National Overview

Education is strictly a provincial government responsibility in Canada and the country, alone among the OECD member states, has no national Department of Education or policy standards. Some coordination is provided by the Council of Ministers of Education, Canada (CMEC), supported by comparative research conducted until 2010 by the Canadian Council on Learning, based in Ottawa (CMEC, 2015; CCL, 2011). All ten provinces and the three territories have established and maintain "distance education" programs within their K-12 publicly funded school systems. The Western provinces of British Columbia (BC) and Alberta have the most extensive online presence, in terms of percentage of student participation. Canada's most populous province, Ontario, has experienced the most recent spurt of growth in student enrolments in distance education and blended learning. The smallest of the ten Canadian provinces, Prince Edward Island (PEI), has the least participation. Three of the provinces, Nova Scotia, Newfoundland/Labrador, and New Brunswick, have a single, provincially managed online program. Three provinces, Ontario, Saskatchewan, and BC, have primarily school district-based programs. In Quebec, Manitoba and Alberta, online programs are a combination of provincial and district-based. The three territories, Northwest Territories, Yukon and Nunavut, and Prince Edward Island (PEI) use online programs from other provinces. Provincial regulations for online learning exist in BC and Nova Scotia, but Quebec, Saskatchewan, and Alberta continue to operate without much regulation of distance learning at all. Flexibility and openness to innovation are bigger factors than regulatory restrictions in explaining the extent of K-12 distance, online and blended learning activity (Barbour & LaBonte, 2015).

The shift to online and digital learning in Canada has attracted the attention of Canadian teacher unions, evoking trepidation varying in degree from one province to another. The Canadian Teachers Canadian Teachers Federation (2000) was the first educational organization to begin tracking K-12 distance education participation levels, focusing on the implications for teachers' class loads and working conditions.

In British Columbia, distance learning gained earlier and wider acceptance, and the BC Teachers Federation funded some of the research (Kuehn, 2006). From 2013 to 2014, the Alberta Teachers' Association (ATA) was instrumental in mobilizing a "Stop Distance Education Cuts" movement (www.stopdecuts.org) aimed at sustaining funding through the public school system. "Students need choice and flexibility in their learning opportunities," the ATA stated. "By cutting funding to schools that use Distance Education, the government is effectively cutting choice and flexibility for students to complete their high school education" (ATA, 2013a) (Fig. 17.2).

Provincial regulations governing Nova Scotia online learning are a response to initial concerns raised by the Nova Scotia Teachers Union (NSTU). When presented with innovative online programs, the instinctive response was to defend existing teacher contract provisions, limiting workload and hours of instruction to those established for classroom-based teachers (Bennett, 2012; Barbour & LaBonte, 2015, p. 13). Another line of defense was and remains to resist online programs, unless and until they can be offered equally to all students. Education school research conducted by Dianne Looker and the Equity and Technology Research Alliance has served to focus resources on "the inclusion of marginal youth" using

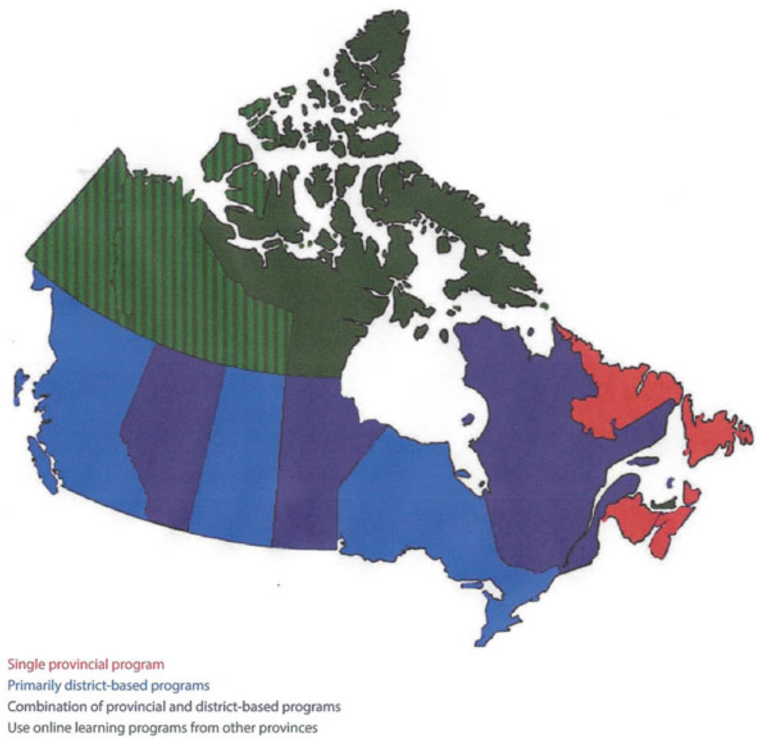

Fig. 17.2 Online learning programs by province and territory, 2015 (Canadian e-Learning Network)

ICT to build upon their "distinctive cultural knowledge" and serve their "economic interests" (Looker & Naylor, 2010).

Distance education serves as a supplementary curricular program in most of Canada's provinces and territories. Up until 2014, some provinces continued to deliver distance education in the static form of e-links to web postings of print-based learning materials. Growing numbers of schools are making use of synchronous tools such as traditional video conferencing or virtual classroom software. Across Canada, however, K-12 distance education is often used interchangeably with online learning even though most such learning does not actually take place online. Surveying the various provincial and territorial programs, it is clear that distance education provides an attractive alternative when face-to-face learning is not feasible or affordable, or for students requiring alternative delivery methods for remediation or course credit recovery purposes (Barbour, 2010, pp. 14–16). Without public charter schools pushing at the boundaries of virtual schooling and blended instruction, as in the USA, online learning primarily exists to provide K-12 courses for students that are not available in the brick-and-mortar school system (Barbour SITE, 2015).

Distance or online learning is growing modestly, but it still continues to represent a tiny proportion of the total Canadian school enrolment. Out of a total student population of some five million, the reported distance education enrolment has risen from 140,000 (2.7 %) in 2008–2009 to about 332,000 (6.2 %) in 2013–2014 (Barbour & LaBonte, 2015, p. 13). Some 152,900 of the unique students (representing 46 % of the total) were from two western provinces, BC and Alberta, and enrolled in about 99 "public distributed learning schools." In those provinces, over 12 % of all students are enrolled in some form of distance education, whereas enrolments continue to lag in the four Atlantic provinces, New Brunswick (2.6 %), Nova Scotia (2.2 %), Newfoundland/Labrador (1.3 %), and P.E.I. (0.5 %). In the case of Ontario, the development, since 2006, of a provincial consortium, *e-Learning Ontario*, has fostered growth in distance education enrolment and province has been moving, since 2006, to centralise its formerly school-district-based system under the auspices of a provincial consortium, *e-Learning Ontario*, and in 2013–2014 reported 250,000 blended learning enrolments. Up in the Far North, I. student enrolments range from 33 (0.1 %) in Nunavut to 228 (2.8 %) in the Northwest Territories, in spite of the demonstrable advantages of online learning for rural and remote communities (Barbour & LaBonte, 2015; Barbour PTDEA, 2015).

The Regional and Provincial Situation

Canada's public education system can only be understood through the lens of its discrete regions, composed of provinces and territories. Following the example of the International Association for Online Learning (iNACOL) and CAN eLearning Network reports, this comparative analysis will highlight the regional and provincial

Table 17.1 Registered distance education students, by province and territory, 2013–2014

Province/territory	# of K-12 students	# enrolled in distance education	Percent involvement
NL	67,463	884	1.3
NS	122,643	~2720	2.2
PE	20,131	108	0.5
NB	101,079	2615	2.6
QC	1,307,026	~705,000	5.4
ON	2,015,411	78,095	3.9
MB	200,807	~12,000	6.0
SK	172,205	~10,000	5.8
AB	616,375	~75,000	12.2
BC	635,057	77,912	12.3
YT	5122	182	3.5
NT	8204	228	2.8
NU	9728	33	<0.1
Federal	106,500	~1800	0.1
Total	5,387,724	332,077	6.2

Estimates compiled by Canadian e-Learning Network, reproduced from Barbour, State of the Nation Study: K-12 Online Learning in Canada (Yellowknife, NWT: Provincial and Territorial Distance Education Association

variations in the current provision of online and digital education. Nine of the ten Canadian provinces have their own K-12 distance education programs; the exception being Prince Edward Island. Two provinces, Newfoundland/Labrador and New Brunswick maintain single, centralised, province-wide systems. Nova Scotia has its own system, but was built in collaboration with a small number of regional school boards. Ontario and Saskatchewan are remarkably decentralised, delegating much of online learning to consortia or remote school districts. Online learning in P.E.I. and the territories might be described as limited in its reach (Barbour & LaBonte, 2015) Only British Columbia, Ontario, and Alberta have, so far, proven to be fertile ground for private school ventures in the form of virtual or online schools (Barbour, 2010, p. 41; Kuehn, 2013). The rise of virtual schooling delivered by "cyber charter schools" has surfaced as a public policy issue in Alberta, where a University of Alberta research unit, Parkland Institute, released an October 2013 report warning of the dangers of "pedagogical innovation" in the form of privatization presented as a way of easing "budgetary constraints" (Clements & Gibson, 2013) (Table 17.1).

Atlantic Canada

Canada's four eastern most provinces, Nova Scotia, New Brunswick, P.E.I., and Newfoundland/Labrador, compose the Atlantic region and do cooperate on joint curriculum projects, given their relative close proximity to one another.

Province-wide distance learning programs exist, managed by the Departments of Education, but only Nova Scotia has developed a regulatory regime to govern the provision of online education. All online programs are sponsored by the provinces, some in collaboration with district boards serving rural areas.

Distance education in **Newfoundland and Labrador** originated in 1988–1989 with the advent of a single advanced Mathematics course, involving 13 schools and utilizing a telematics or audio graphics delivery system. A Centre for Distance Learning and Innovation (CDLI) was established in 2001–2002 with ten different courses field-tested enrolling 200 students in 76 different rural schools (Barbour, 2005). In its first decade, DLCI expanded to offer 38 courses with some 1600 course registrations each year. In 2013–2014, 884 students were enrolled in 39 different courses totalling 1576 registrations (Barbour & LaBonte, 2015). The Newfoundland high school program offers synchronous instruction matching regular school times and using *Elluminate* software and asynchronous instruction supported by the *Desire2Learn* course management system. Some online instructional support is also offered in the lower grades. That province is also home to the Killick Centre at Memorial University, a leading online education research center. The Ministry of Education tracks online education delivery and maintains a *K-12 School Profile System*, but, as of October 2015, there were no policies or regulations for distance education beyond those utilised by CDLI. While e-Learning was recognised as one of eight NL Education "lines of business," provincial regulations were reportedly only under discussion (Barbour & LaBonte, 2015; Barbour & Mulcahy, 2009; Crocker, 2007).

Nova Scotia has developed its own province-wide online learning program—the *Nova Scotia Virtual School* (NSVS). It provides a central course management platform and delegates to the eight school boards the responsibility for providing course content written by practicing classroom teachers (Bennett, 2012). The province's French school board, *Conseil scolaire acadien provincial* (CSAP), has a longer history of offering online courses, shared jointly with New Brunswick. Since Nova Scotia has tended to lag behind in providing province-wide high speed Internet access, concerns about the urban–rural "digital divide" exert considerable influence on educational policy-making (Looker & Naylor, 2010, pp. 117–136). In 2013–2014, the province's correspondence studies program was being transitioned to an online delivery format. Although Nova Scotia has no K-12 distance education legislation, 11 provisions in the Teachers' Contract with the Nova Scotia Teachers Union (NSTU) set out the parameters for current and future activity. Combined student enrolment in NSVS and correspondence courses totalled 2720 in 2013–2014, composed of 970 in VHS and 1750 taking correspondence courses (Barbour & LaBonte, 2015, p. 13).

The Nova Scotia regulatory regime respects negotiated teacher rights. The 11 specific clauses in the Agreement set out the rules of engagement and, in effect, limit the provincial government's freedom of action in providing online learning. All online instructors must be certified teachers, employed by one of the eight boards, and are protected by provisions limiting their number of instructional days and working hours and guaranteeing teachers personal days as well as dedicated preparation and marking time. Distance education is treated like a regular in-school program with supervisors, dedicated facilities space, and class groups limited to 20–25 students. A provincial Distance Education Committee, with teacher union representation (four of eight positions) exists to address "issues surrounding distance education"(NS Education, 2011).

The Nova Scotia Department of Education and Early Childhood Development (DoEECD) **is** starting to embrace digital learning in close partnership with Google and tethered to Google Apps for Education (GAFE). After piloting the program in a number of schools in 2014–2015, the DoEECD decided to make GAFE available to every single child and teacher in the 400 schools across the province. Twenty thousand out of Nova Scotia's 118,000 students are now using free computer software from Google as part of their classroom activities. Provincial education officials expect Google Apps for Education to be nearly universal by the end of 2016–2017. The cloud-based suite of programs can be accessed on any electronic device with an internet connection and a web browser. It includes email, word processing and assignment management software. Some school boards have chosen to issue students $200 devices called Chromebooks to let them access Google products at school and at home (Julian, 2015).

Prince Edward Island is geographically small and makes minimal provision for distance or online education. Two Ministerial Directives, issued in 2001 and in August 2008, set out the provincial guidelines and authorise, for P.E.I. credit purposes, distance education courses offered by New Brunswick and other provincial jurisdictions. A provincial video conferencing system exists, but it is little utilised by the Education Department or students in local schools. In 2013–2014, only 108 students out of a 20,131 total student enrolment were enrolled in online courses (Barbour, 2011; Barbour & LaBonte, 2015, p. 14).

Two online learning programs are offered in **New Brunswick**, one in the English language, the other in French, and serving the dual linguistic school system. While the program reflects the province's bilingual reality, it is delivered by the same Ministry learning management system (LMS). Student enrolment consists mostly of students supplementing their regular in-school studies and it was relatively static or slightly declining from 2007 to 2012, in both the Anglophone and Francophone sectors. While New Brunswick was an early champion of "21st Century Learning," provincial budget restraints from 2010 to 2014 limited the proliferation of ICT across the province (NB Education, 2010; Barbour & LaBonte, 2015). From 2008 until 2014, the NB Ministry of education averaged 2200–2650 enrolled in their distance education courses. Steadily increasing numbers of students were enrolled in face-to-face courses registered in the NB learning management system where their teachers were using online material to teach the course. In 2013–2014, some 943 English students and 1511 French students were registered in these "blended" learning activities. Recent growth in student enrolment in online courses, according to the NB Education Department, is attributable to expanded First Nations language course offerings and meeting Special Education course demands to serve severely learning-challenged students (Barbour & LaBonte, 2015, p. 15).

Central Canada

Canada's two most populous provinces, Ontario and Quebec, are home to some 20 million people or 60 % of the nation's total population and the lion's share of its K-12 students. Distance education programs in Ontario and Quebec are province-wide, but mostly offered at the district or school board level. Ontario has a strongly rooted tradition of locally managed district programs, while Quebec has only recently begun to devolve management from the Ministry of Education to the district level. The provision of such programs in Ontario has undergone a distinct shift in management and control since 2006 with the emergence of two distinct e-learning consortia, Anglophone and francophone, and the expansion of rural distance learning projects.

Quebec is a distinct, unique French-speaking province with a majority Francophone K-11 school system and a separate one for the Anglophone minority population. Secondary school extends from Grade 7–11 and thereafter students attend a 2-year *College d'enseignement general et professional* (CEGEP) to secure a university-preparatory diploma. The earliest distance education courses originated as part of the vocational studies movement back in 1946. In April 1996, Quebec school boards took the big step on establishing a provincial nonprofit organization to produce online resources known as *Société de formation a distance des commissions scholaires du Quebec* (SOFAD). That organization produces distance learning materials in French for students 16 and over, offered through district-based programs in some 57 regional centers and, by 2013–2014, serving 56,608 students (Barbour, 2010; Barbour & LaBonte, 2015).

Quebec's English sector developed its own Distance Education and Community Network, founded in 1999–2000. Over the next 6 years, it grew to encompass all nine English-speaking school boards and morphed into Leading English Education and Resource Network (LEARN), known as *LEARN Quebec*. The Quebec English distance education agency provides a variety of distance learning offerings, enrolling over 8500 English-language students from across the province. In addition, close to 36,500 students are served by LEARN managed blended learning asynchronous services (Barbour & LaBonte, 2015, p. 17).

Even though Quebec's Education Act makes no reference to distance education, the province is emerging as a leader in promoting online learning in small rural schools. The Ministry of Education has funded *Écoles éloignées en réseau* (EER) since 2002 and the Rural Networked Schools (RNS) initiative has broken new ground in distance education. Instead of simply compensating for the absence or closing of a school, the program serves existing schools by "networking" certain learning activities in an effort to enhance the quality of education by broadening access to resources (Barbour, 2010, pp. 12–13). By 2009–2010, the RNS initiative had expanded to some 20 Francophone school boards encompassing 70 schools and involving about 90 teachers (Barbour, 2011, pp. 41–42). During 2013–2014, EER engaged 392 teachers in 214 different schools and connected more than 4600 students through use of Knowledge Forum and various synchronous tools. One rural

Quebec school district, Beauce-Etchemin, also offered 16 remedial online courses as well as nine full-time online courses, enrolling some 700 students in eastern Quebec (Barbour & LaBonte, 2015).

Canada's most populous province, **Ontario**, spent $23 billion on education in 2013–2014, operating 4897 schools and serving some two million students. While Ontario is a massive province geographically, distance education lagged for many years and, for the most part, suffered from a confused sense of direction. Since 1994–1995, many of the province's school boards have established their own district programs and then in 2006 20 of the boards formed the Ontario e-Learning Consortium (OeLC). That joint venture has helped increase course offerings and the sharing of resources with positive results. From 2008–2009 to 2009–2010, online student enrolments in OeLC boards jumped from 6276 to 9695. The consortia model has also been replicated by Ontario's French language boards and by the province's constitutionally guaranteed separate Catholic school boards. In 2010, a Northern e-Learning Consortium (NeLC) was established to allow remote northern Ontario school districts to address shared challenges (Ontario Education, 2011).

Growing demand in Ontario for online student learning has manifested itself in the recent emergence of private venture virtual schools. Three different private K-12 online learning programs are flourishing outside the state regulated school system: Virtual High School (VHS Ontario), Ottawa Carleton e-School (Ottawa), and Keewaytinook Internet High School (Nishnawbe Aski Nation). By 2009–2010, some 3140 of the 4700 students in private online schools (or two-thirds of the total) were enrolled at the phenomenally successful VHS (O), founded in 1995 by Steve Baker and a team of Huron County public educators and based in the small town of Bayfield, Ontario (Bennett, 2012). Each of these private operations has found a niche by serving needs being unmet in K-12 Ontario public education.

Ontario's regulatory regime, outlined in the 2006 *E-Learning Strategy* and codified in school regulations initially imposed limits on the delivery of online learning. "In some instances," North American online learning expert Michael K. Barbour reports, "the Ministry requirements were once quite restrictive." Originally, the Ontario provincial LMS could not be used for either blended learning or the professional development of teachers. That led school districts to run parallel systems, the provincial LMS as well as their own separate LMS for those other purposes (Barbour, 2010). Beginning in September 2011, Ontario loosened its regulations and embraced blended learning as part of its system. By 2013–2014, the best estimates were that about 52,095 students were taking e-learning courses, including summer school, from school boards through the Ontario Ministry's virtual learning environment and the records showed 237, 930 unique blended learning logins. In addition, 20,000 Ontario students were enrolled in correspondence courses and about 6000 in private online schools (Barbour & LaBonte, 2015, p. 18) (Figs. 17.3 and 17.4).

The route to expanded eLearning in Ontario was through the bargaining table. The leading Ontario teachers' union, the Ontario Secondary School Teachers Federation, weighed in on this matter at their 2010 annual meeting. The big issue, for the OSSTF, is not quality programming but rather closing the so-called "digital

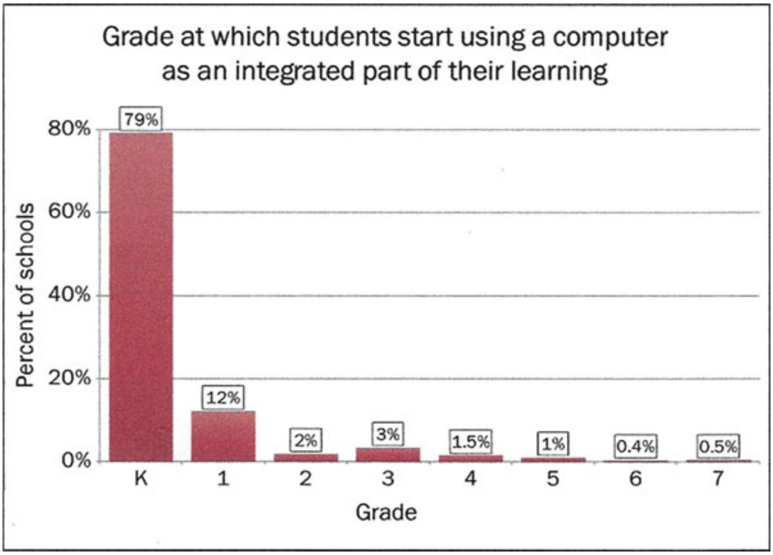

Fig. 17.3 Digital technology use by elementary school students, Ontario, 2013–2014 (Reproduced from Bodong Chen, Kelly Gallagher-Mackay, and Annie Kidder, Digital Learning in Ontario Schools: the 'new normal,' Toronto: People for Education, 2014)

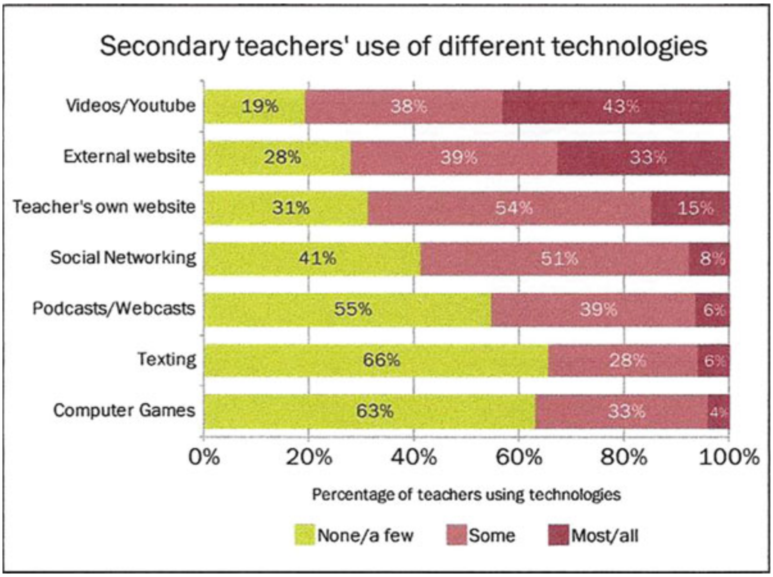

Fig. 17.4 Integration of technology by secondary school teachers, Ontario, 2013–2014 (Reproduced from Chen, Gallagher-Mackay and Kidder, 2014)

divide" separating students fully equipped with the latest e-tools and those without such access (Bennett, 2012). While there is an "ICT competency divide" between urban and rural Ontario, opinions differ on whether it should limit the pace and scale of the online learning movement (Newman, 2010). Now that the door is open to blended learning the province is moving more quickly to provide student and teacher access to online tools and courses. The leading Ontario parent lobby group, Toronto-based People for Education, has emerged as a champion of "digital literacies" (information, media, and ICT) and the promotion of ICT to enhance student learning (Chen et al., 2014).

Western Canada

Western Canada is home to Canada's growth-oriented resource producing provinces, Alberta, British Columbia, and, more recently, Saskatchewan. Vast stretches of the region's northern frontier would seem to be prime territory for the introduction of remote online learning. Two of the four provinces, BC and Manitoba, have centralised K-12 distance education programs. The leaders in providing distance education are British Columbia and Alberta, while Saskatchewan has lagged behind in terms of student enrolment. Without the financial resources of its neighboring provinces, Manitoba has still managed to demonstrate some ITC innovation and to enroll between 8000 and 12,000 students per year. British Columbia is the only western province with formal "distributed learning" regulations. Since renewing its online learning strategy, Alberta has closed the gap and is now more competitive with BC in the field of digital learning (Barbour, 2010; Barbour & LaBonte, 2015).

Manitoba has developed its own online learning strategy and mix of support programs. The Department of Education, known as Manitoba Education, operates three distance education programs: Independent Study Option (ISO), with print-based delivery for Grade 9–12 level students; the Teacher Mediated Option (TMO), which uses audio conferencing; and the Web Based Course (WBC) option, operated by Manitoba Education in collaboration with local school districts. With WBC, the Department develops the approved courses, supervises teacher training and support, and finances the learning management system. Schools are left to implement the WBS's, including the hiring or assigning of teachers, and the costs are covered by regular per-student block funding from the province. A separated Francophone Division of Manitoba Education offers ISO and WBC courses for students registered in French first language or French immersion programs (Barbour, 2010, pp. 44–45). Manitoba Ministry statistics for 2013–2014 show 2960 enrolments in the ISO, 379 in TMO, and 8600 in the WBC option. With the creation of a Manitoba "virtual collegiate," online and blended learning opportunities are forecasted to expand and a Wapaskawa Virtual Collegiate, initiated under a Memorandum of Understanding (MOU) with the Manitoba First Nations Education Resource Centre (MFNERC),

Saskatchewan's K-12 distance education program was once centralised and much like that of Manitoba. Under the aegis of the Ministry of Education, the province developed courses delivered online, televised via satellite, or using print-based materials. In 2009–2010, the province delegated most of the responsibility to its 28 school divisions and responded to public concerns about the "digital divide" by continuing to invest in providing print-delivery to students unable, for whatever reason, to access the Internet (Barbour, 2010, p. 47). Sixteen of the 28 school districts in 2013–2014 operated or participated in some type of distance education program. School districts without distance learning courses collaborated with other districts to provide students with online course options. It is estimated that about 10,000 (5.8 %) of Saskatchewan's 172,205 students during 2013–2014 were engaged in some form of online learning, registered with the Saskatchewan Distance Learning Course Repository or with one of 21 different K-12 programs. Distance education is guided by the Saskatchewan Technology in Education Framework (TEF) which promises to further extend "equitable access to high quality instruction" through "flexible approaches" aimed at meeting "the diverse needs of students and teachers" in each school division. Under Saskatchewan's 2013 Bullying and Cyberbullying Action Plan, Digital citizenship courses will be offered to all K-12 students (Barbour & LaBonte, 2015, pp. 21–22).

Alberta stands out as Canada's leading oil producing province and the one most committed to school choice for students and families. "Choice," Alberta Education proclaimed in 2011 on its website, "is one of the important principles Alberta's education system is built on." When it comes to selecting schools, parents and students can choose from a wide range of options and among the publicly funded choices are regular public schools, separate Catholic schools, Francophone schools, and charter schools. Parents can also secure grant support to home school their own children. That overall philosophy of choice is also reflected in the province's online learning programs (Alberta Education, 2011).

Distance learning in Alberta has evolved in form to the point where, in 2013–2014, the province operated over 23 K-12 distributed learning programs. Flexibility is the overriding philosophy and Alberta Education professes a commitment to support "learning environments" which allow teachers and students to utilise a wide range of teaching and learning resources in "a regular classroom setting or in different, non-centralised locations" while "separated by time and/or place for some or all of their learning activities." A provincial Alberta Distance Learning Centre (ADLC), based in the Pembina Hills school district, offers courses in the full range of formats from print correspondence courses to online formats blended with in-school programs to Vista Virtual School, a full day school. The ADLC also partners with *Centre francophone d'éducation a distance* that provides distance education services to Alberta's francophone students. School districts are also free to offer their own online learning programs and many exist in the state-funded Catholic school system as well as the standard public system. District-based programs come in many varieties, including an online school for Indigenous students, SunChild E-Learning Community (Barbour, 2010, pp. 49–50; Barbour, 2013, p. 57).

Alberta's school choice philosophy encourages innovation and, since 2007, the province has exploring and developing a succession of policy initiatives, ranging from "distributed learning" to "open access" and attempted in June 2010 to reframe educational innovation, providing teachers with the freedom to design and deliver instruction "face-to-face, online, and in other non-traditional environments" (Alberta Education, 2010, p. 21). With the Alberta government exploring all policy options, including "cyber charter schools," the ATA stiffened its position, condemning such ventures as a "clear threat to public education" (ATA, 2013b). Since the province does not collect province-wide distance education enrolment data, the CAN eLearning Network figure of 75,000 (12.2 %) of the 616, 375 students amounts to a rough estimate for 2013–2014. A provincial policy review, initiated in April 2012, may help to provide more integration of the various types of online, blended, and virtual learning (Barbour & LaBonte, 2015).

British Columbia continues to lead in the provision of K-12 online learning for students. With a total student population of 635,057 in 2013–2014, BC ranked first in online registration with 77,912 unique students enrolled in one or more online courses. The primary distance learning programs, unlike many other provinces, are district-level based and offered in some 60 public "distributed learning schools" as well as some 16 independent or private "distributed learning schools." The province also has a single, one-stop portal, *LearnNowBC*, for students, parents, and teachers to use when accessing information about all publicly funded distributed (online) learning in BC. That portal provides a complete catalogue of courses, a searchable database, and access to free services, including tutoring, advising, and homework advice for elementary as well as secondary level students. Another online resource, *Open School*, originally developed by BC Education, is also available, on a cost-recovery basis, providing provincial curriculum content and hosting services to district boards in need of such support (Barbour, 2010, pp. 51–52; Barbour & LaBonte, 2015, p. 24).

British Columbia's school law has recognised and enabled "distributed learning" since 2006. Under the School Act, BC lets the school districts decide on how to deliver online learning. Students in public schools are permitted, with prior approval of the Ministry, to enroll in educational programs falling under multiple jurisdictions or boards of education. Schools authorised as "distributed schools" offering online programs are subject to regulations, including the stipulation that boards only employ "BC certified teachers." While the BC Teachers' Federation is more open to "distributed learning," the union remains cautious in its support (Barbour, 2013, p. 15). Since 2006, the provincial funding model has been implemented, based upon student course load, and pro-rated based upon who is delivering the courses. Neighborhood schools receive a "DL Support Block" grant to compensate them for accommodating online courses and each online course is designated as worth 1/8 FTE in the funding formula. Given the size of the BC online learning program, regular quality assurance audits now include a review of alternative online programs (Winkelmans, 2010). While the BC Teachers' Federation is more open to "distributed learning" than other provincial teacher associations, the BCTF remains cautious in its support (Barbour, 2013, p. 15).

In British Columbia, independent private schools are provincially funded and this has greatly assisted in the spread of what are termed "distributed learning independent schools." In 2013–2014, there were 16 such schools, taking advantage of a 50 % BC provincial grant to operate, in most cases, without charging tuition fees. In a province where independent schools compose 12 % of the total K-12 student population, some 21 % of all distributed learning enrolment (by 2009–2010) was to be found in independent schools. The province's largest distributed learning school, Christian Heritage Online School in Kelowna, BC, enrolls over 2000 full-time students and has an additional 3000 students taking one or two courses. Much of Heritage Christian School's appeal, according to IT Director Greg Bitgood, was attributable to innovative technology which provides ongoing tracking of student progress and individualised programs of study for each student (Bitgood, 2011). A BCTF research report (Kuehn, 2013) claimed that provincial funding enhancements had fueled dramatic increases in private distributed school enrolment, threatening the publicly funded school system.

Northern Canada

Canada's northern territories face many social challenges that impact upon the delivery of not only online courses, but most regular education programs. All three of the territories, the Yukon, North West Territories, and Nunavut, are on the Canadian educational frontier and far removed from the main southern population centers. Student attendance and teacher turnover are critical factors affecting the delivery of public education (Barbour, 2011, p. 54). The territories have tended to utilise the K-12 curriculum from one of the southern provinces, until recently. The same is true for distance learning. The Yukon has utilised the BC curriculum, while North West Territories and Nunavut use the Alberta Education program. Local initiatives have emerged in the Yukon and Northwest Territories, in a region where tackling the underlying social challenges takes precedence over online learning initiatives.

The Yukon, the smallest of the Northern territories in size and population, currently has 28 K-12 schools serving a growing student population that reached 5122 in 2013–2014. Distance education began in 1998–1999, with the introduction of a Yukon Grade 11 pilot course in Information Technology with a dozen students. Since 2004, the territory has operated a territory-wide video conferencing program, linking Whitehorse schools with outlying remote communities. Yukon students are also able to take advantage of BC's *Open School* program. In 2008–2009, Yukon had agreements with eight distance education schools, including the Northern British Columbia Distance Education School (NBCDES) and the Alberta Distance Learning Centre. During 2010–2011, some 80 students were enrolled in one or more of 29 different courses offered in Yukon under interprovincial agreements (Barbour, 2011, p. 52).

Digital learning is gaining traction in the Yukon Territory as student enrolments continue to rise. Yukon Education supports a Distributed Learning Program managed by the Aurora Virtual School (AVS) that in 2013–2014 served 42 home-educated students and 140 in-school students taking at least one course online. Blended learning programs are emerging in Yukon schools and the territorial education department has embraced the "flex model" (Staker & Horn, 2012) and is tracking its implementation. A 2014 CAN eLearning Network report estimated that 182 students or 3.5 % of all students were officially enrolled in distance education, but blended learning activity using the "rotation" model was becoming more common (Barbour & LaBonte, 2015, p. 25).

The Northwest Territories lags behind the Yukon in exploring new approaches to distance education. In 2013–2014, its population totalled 43,642 living in the Yellowknife and widely scattered native communities. Although the Territories had 49 schools, the growing student population only numbered 8204 (Barbour & LaBonte, 2015, p. 27). Completion rates in online courses, according to a 2005 report, were very low, with only 1 out of every 3 recording a passing grade (Barbour, 2010, p. 57) The most northerly school board, the Beaufort-Delta Education Council (BDEC), introduced its first online (Internet-based) courses in 2009–2010, delivered on the Internet with teachers using *ElluminateLive* software and whiteboard technology (Barbour, 2011, p. 55). Some 228 students were enrolled in distance education during 2013–2014, most taking courses offered through the Alberta Distance Learning Centre (Barbour & LaBonte, 2015, p. 27).

Canada's youngest northern territory, **Nunavut**, was granted sovereignty and partitioned from the Northwest Territories in 1999. Ten years later, in 2009, a *Together at a Distance* program, headed by Neil Burgess, former Nunavut IT Manager, established an online learning portal using *Moodle* software and attempted to provide "made-in-Nunavut" learning resources (Burgess, 2011). With its small but growing population of 35,591 this territory had 42 schools in 2013–2014 enrolling 9, 728 with student numbers growing by some 9 % a year (Barbour, 2011; Barbour & LaBonte, 2015, p. 28). Nunavut schools follow the Alberta K-12 school curriculum. In the most recent Can eLearning Network study, no active K-12 distance education courses were reported for the whole territory. A territorial policy on access to and delivery of distance education, initiated in 2012, is still underway (Barbour & LaBonte, 2015, p. 28).

Federal Schools

Canada's federal government is responsible for the provision of First Nations education on the country's native "reserves" through Aboriginal Affairs and Northern Development Canada (AANDC), recently renamed Indigenous and Northern Affairs Canada (INAC). Some 60 % of First Nations students attend students on reserve, funded by AANDC/INAC and managed in collaboration with Band Councils and a number of First Nations education authorities (Bennett & Anuik, 2014). For students who live on reserve but attend provincial schools off-reserve, the federal department pays the tuition that the province charges non-Aboriginal students, normally through provincial or school board authorities. Four distance education programs existed in 2012–2013, designated as First Nations, Métis and/or Inuit (FNMI) programs and enrolling an estimated 1800 of the 106,500 identified students. In 2013, AANDC devolved the responsibility for entering into e-learning program service agreements to First Nations education authorities, phased in and taking effect in 2015–2016. Some First Nations education authorities and regional councils are actively exploring enhanced distance and online learning, but face significant barriers, including scarcity of resources, lack of bandwidth or connectivity, or shortage of expertise (Barbour & LaBonte, 2015, p. 29).

Overall Assessment: The Present State and Future of Digital Learning

Digital learning is on a growth curve in Canadian school systems, but without the radical variations, free market experimentation, and “disruptive” innovation found in the USA (Christensen, Horn, & Staker, 2013; Chubb, 2012; Moe & Chubb, 2009; Peterson, 2009). Significant gaps still exist in service levels and barriers stand in the way of expansion into un-serviced frontiers, particularly in the Far North and First Nations communities. In all of Canada’s provinces and territories, including Alberta, school choice is rationed or limited, learning conditions are carefully state regulated, and the delivery of education is circumscribed by “brick-and-mortar” schooling. Virtually all Canadian educational systems remain designed around seat time, defined as providing in-school classes of regulated size with a minimum number of instructional hours (Jensen et al., 2010; Powell et al., 2015). Some private sector virtual schools have recently arrived and thrive outside the mainstream system. No full-time online public charter schools exist, even in Alberta, the only province in Canada with Charter School legislation (Bennett, 2012). Distance education and online learning student enrolments continue to grow incrementally in the nation’s provincial/territorial systems and in “have not” jurisdictions where expansion is limited by budgetary spending limitations (Barbour and LaBonte BIT, 2015).

The growth of online learning in Canada may be more significant than reported by provincial and territorial authorities. While Quebec and New Brunswick both reported modest distance education enrolments in 2013–2014, estimates for teachers using the curriculum in blended format are much higher. From 2011 to 2014, to cite another example, the Ontario Ministry of Education coordinated an initiative to expand access to blended learning for all K-13 students, which generated almost

240,000 blended learning enrolments in the provincial learning management system during the 2013–2014 school year. If and when provincial authorities begin tracking the extent of blended learning, the actual rate of growth will be shown to be much higher than the official statistics (Barbour & LaBonte, 2015).

Digital learning has entered the education policy discourse in most of Canada's ten provinces and three territories. Without a national education department, the promotion of twenty-first century skills, technology, and learning falls to provincial and territorial education authorities with varying degrees of commitment to technology education reform. The national advocacy group 21C Canada holds some sway over provincial ministers of education (C21 Canada, 2015), but, so far, the implementation of twenty-first century learning and the explicit teaching of "digital literacies" is very uneven, particularly outside of the recognised leaders among the provinces, Ontario, British Columbia, and Alberta (Chen et al., 2014). Blended learning is on the rise, as an outgrowth of the natural evolution of online and face-to-face education from 2008 until 2015. Newer blended learning models, promoted by the Christensen Institute (Powell et al., 2015), are beginning to emerge in the so-called "hybrid zone" in what might be termed "lighthouse" schools. While provinces such as BC, Alberta, and Ontario actively promote eLearning, innovation is limited by the current structural boundaries and education authorities are only beginning to track blended learning enrolment. In 2012–2013, British Columbia enacted legislation enabling "flexible learning choices" and, with the support of the BC Distributed Learning Administrators' Association (BCDLAA), blended learning and "flipped classroom" practices are becoming more mainstream (Barbour, 2013, pp. 61–62). Google Apps for Education has now surfaced as an affordable software option for cost conscious school jurisdictions. National online education survey reports, produced by the CAN eLearning Network (Barbour and LaBonte BIT, 2015), testify to the steady growth of distance education and online programs, but identify the need for "better data" and more evidence of the transition to "competency-based learning" in Canada.

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Chapter 18
Flip the School, Forget the Classroom; How to Enable Personalised Learning with the Help of Information Technology

Maurice de Hond and Tijl Rood

Abstract In this contribution we explore how information technology can help individualized learning in schools. Rather than tweaks, schools need a complete makeover. Analysis of the results of our test school in Amsterdam shows that freedom of choice leads to responsibility, leads to motivation, leads to higher learning outcome.

Keywords Flipped classroom • Personalised learning • Digital tools • Information technology • Individualised learning • Schools • Classroom environment • And on recent difficulties • Educators • Organizational and the • Educational transformation • Educational goals

In this contribution we explore how information technology can help individualised learning in schools. This has been the Holy Grail for the education profession since Helen Parkhurst (1922) and Maria Montessori (1993) made their compelling calls to reform traditional classroom based education into individual experiences, based on individual for goal setting.

Up until now, many attempts to put this goal into practice, have failed, or faced erosion for reasons of efficiency (van Duijne, van den Tempel, & ter Welle, 2015). Our ambition is to show that by deploying digital tools schools now can (and therefore, should) transform their operations into a collection of personalised learning experiences rather than persist in a one-size-fits-all approach.

The need for this transformation is not the availability of the tools itself. Education has been functioning rather well over the past 124 years; in 1892 the Prussian model of standardised education was adopted in the USA and became a worldwide standard (Armytage, 1969–2012). Since then, each generation showed higher intelligence and higher education levels than the one before (Resing & Nijland, 2002). But while society faced the digital/information revolution, the education system did not divert

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from the goals that were set by the industrial revolution (Collins & Halverson, 2009). Education raises a workforce that is capable of performing standardised tasks in clearly defined time spans; just what the twentieth century needed. Compliance is a strong asset for blue and white collar workers, who have to complete dull tasks in a routine fashion that does not differ much from one worker to another.

Four Types of Learning

Since society faces a new phase in which robots will take over not only simple mechanical tasks but also more complex ones, and in which artificial intelligence will, at least partially, equal the human brain (IBM's Watson is about to pass the medical examination and will be a licensed medical practitioner soon) (Simonite, 2014), we do not need a workforce that is only compliant and capable of routine tasks. Instead, critical and creative thinking are qualities that will be sought for.

It is easy to acknowledge that in order to meet society's demands, we will have to say goodbye to the well-known organizational principles that "make" education today. No longer do we need to stress to "behave" in a group of peers who are basically doing the same things for the whole day. Instead, we have to empower children to complete tasks that are relevant for their learning goals, or tasks that result from their participation in "enterprises" or research projects.

Before we can focus our attention on the ways we can organise this, it is important to understand the nature of personalization in education. Personalization differs from differentiation and individualization in two dimensions: the locus of control and the social context of the work that is being done.[1]

If we cross these two dimensions, the result is four types of learning:

	Internal locus of control	*External locus of control*
Individual work	Individualised learning (Montessori)	Differentiated learning
Collaborative work	Personalised learning	Group learning

If we follow the table clockwise, we see that individualised learning is able to meet both the demands of a fixed curriculum and personal learning goals; if we add ICT to this type of learning, the danger might be that children or students don't feel connected with their peers when the usage of screens gets heavy. Not only are the children or students looking at a screen, but there is no connection in the type of activity either.

Differentiated learning is a system that works fine, since it is mainstream education and thus the benchmark.[2] But it is an organizational challenge, and a constant strain on the administrative qualities of teachers. Because children or students are

[1] This double dichotomy seems to work better than the original trichotomy that is proposed by Bray and McClaskey (2013), since group learning and drilling do not fit easily in that model.

[2] In many countries, the effectiveness of Direct Instruction Model and other forms of differentiation in the classroom is widely accepted and hardly discussed; the didactics are even actively promoted by authorities, as for instance Onderwijsinspectie in The Netherlands. Yet this is not an evidence based approach. (See for instance: Hattie, 2008; Schomker, 2006).

grouped in different level groups, that vary from subject to subject, the teacher is constantly struggling to organise a meaningful learning day for as many children as possible. A big disadvantage is of this type of learning is that the learning itself is perceived as something that has to be done rather than something that helps oneself to improve. Moreover, despite the constant focus on learning outcome, on close examination one easily sees time and attention leaks.[3]

Group learning can be very effective; see for instance the approach of whole brain learning or the drilling practice in military schools.[4] The approach has two disadvantages. Firstly, it hardly meets the demands of higher and lower cognitive skills, and it has a hidden learning effect: becoming an obedient part of a group is more important than developing one's own individuality.[5]

Personalised learning reflects the situation that children or students will encounter in their future lives and careers: combining ones individual needs and strengths within a combined team-effort. Whatever our work will be, it is never a sole operation; even self-employed workers have clients and suppliers, with whom they coproduce the outcome.

Moreover, personalised learning is efficient because the tools are adaptive; no time is wasted on tasks that are too difficult or too easy, the learning content is tailor-made and connected to individual learning goals, thus leaning on a stronger motivation. Research (Hattie, 2008) is conclusive: the more children are involved in discussing their own learning goals and paths, the more efficient they will learn. An internal locus of control calls for constant reflection upon learning activities, the goals they are serving and the manners they are executed in.

The collaborative aspect of personalised learning is interesting. It is claimed[6] that teaching is the best way of learning; setting free this energy by allowing children or students to teach each other can be a powerful tool to enhance learning efficiency. And allowing for this type of activity, sometimes called "tutor-learning," again reflects their future to the extent that in workplaces normally junior professionals pick up skills and knowledge from senior colleagues.

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[3] Although the effects on allocating autonomy to learners in terms of efficiency has no empirical basis yet, at face value we expect an efficiency gain. Empirical studies show that the mainstream approach of differentiated learning has considerable time loss. One third of the time is not spent on learning, but on classroom management, preparation and disruptions. In teacher-led activities, pupils pay attention 7 out of 10 min. Of independent work, pupils are engaged 2/3 (language) or 3/4 (math) of the learning time. In total, of every hour of school time, less than half of the learning time is spent on learning! This is a strong call for reorganizing school. See: Brown and Saks (1986).

That granting autonomy to children is effective has been shown. See for instance: Cordova and Lepper (1996).

[4] The point of Whole Brain Teaching or Whole Brain Learning is attaching gestures to content that must be memorised. Moreover, children teach is other by repeating (all at the same time) whatever the teacher has just said. While they do this, they ought to use the gestures; if they do, they earn a glad smiley, and if they fail, a sad one. See: http://www.wholebrainteaching.com/.

[5] See for a discussion of the hidden curriculum: Klaassen and Veugelers (2009). Dimensie vh Onderw/ILO, UvA/UvH. Retrieved December 11, 2015, from http://dare.uva.nl/document/2/73627.

[6] Since Seneca, this claim has been reiterated often and debunked seldomly. See for instance: Gartner, et al. (1971).

Getting Rid of Obstructing Mind-Sets: Farewell Class

Once a school introduces personalised learning, teachers have to say goodbye to many dear old mind-sets. First of all, it is important to understand that the classroom with the fixed group of inhabitants is an impediment rather than an asset. It obstructs tutor learning, does not facilitate different learning styles and cannot be optimised as a rich learning environment for one specific subject. Moreover, “locking up” children of the same age in one room for the whole day provokes bullying behavior and insubordination (Yoneyama & Naito, 2003).

So, the first step to personalization is to let go of the classroom and the concept of class. School immediately becomes a collection of learners, each and every one of them with their own schedule for the day.

One might fear that this results in chaos. We have to let go of an important organizing principle; the classroom and the class of children or students in approximately the same age. To group children or students into classes makes school much easier to organise; the group moves from one room to another, the group has an average score that indicates the level of proficiency of the teacher, organizational issues are communicated to the group.

How are we going to cope with all these organizational issues, once we forget about the group and start delivering education to individuals?

It is at this point that we can grasp the disruptive influence ICT can have on the education. ICT enables us not only to flip the classroom; we can flip the school as a whole. ICT’s influence is not limited to the educational content and the way it is presented, but ICT also affects the organizational principles that define school.

This was our first concern when we started the Steve JobsSchool in Holland: how can we organise personalised education in a way that children or students are still working together and develop their co-working and social skills, while profiting from the efficiency gains that digital learning can offer?

To easily understand what this is all about, imagine a music festival. On various stages artists are performing, not knowing in advance how many visitors they will attract and who these people are. Visitors construct their own schedule from the various acts, free to pick any act they may like. In Steve JobsSchools we do exactly the same; we schedule lessons and other activities, for children to pick from. What activities they select is based on their learning goals that can of course vary from one child or student to another. Software[7] records the choices, translates them into a schedule for the child and shows the teachers who will attend their lessons or activities.

If the scale of the school is large enough, children or students will be able to base their choices not only on the content or subject that they want to cover, but also on the learning style they prefer. [8] That is why it is important that teachers offer a variety

[7] See sCoolTool.eu.

[8] If the concepts of Multiple Intelligences (Gartner) and different learning styles (Kolb) have found no empirical base to the extent that no studies show that applying the concepts is beneficiary to learning outcome, it goes without saying that once education is personalised, it’s a good thing to allow for different learning styles. Why wouldn’t one? Obviously, children or students that are allowed to follow their own preferences thrive better. Even if sandwiches are no healthier than muesli, it is silly to eliminate the choice.

of didactics, from working together without teacher supervision in an enterprise, to following a frontal lesson delivered without any active involvement of the pupils (other than listening and taking notes). This is because children and students differ in learning style, and personalised education takes these differences seriously. In fact, we see that in our schools, pupils actually get to know their preferred learning style and base their choices upon it. Some pupils have motivational problems and need external reinforcement to increase their motivation. Also for them, a school must have a good offering.

Didactics	**Internal locus of control (producing)**	**External locus of control (consuming)**
Intrinsic reward	*Own area of interest*	*Inspiration by the teacher*
	Enterprises, Real products	Instruction and tasks
	Talent workshops, Research projects	
Extrinsic reward	*Task readiness*	*Reinforcement Strategies*
	Silent work	Exam preparation
	Work in studios	Remedial teaching

Obviously, all human beings will prefer activities that have an intrinsic reward ("fun to do," "it shows how good I am at it") and an internal locus of control ("I want to have it done", "this work suits me") and avoid if at all possible the work that has an external locus of control and an extrinsic reward (Someone tells me I have to do it now, If I don't do this, I will fail my test.)

Learning, especially formal and explicit learning, is very often not very rewarding in itself; the reward is to master the skill, rather than experiencing that you are not yet very good at it.

So it is important to make room for all learning activities that have an internal locus of control, and/or an intrinsic reward, but also organise learning activities based on reinforcement strategies. The latter activities can be obligatory for certain children or students; but only after the necessity of this approach is evident.

Empirical study has shown[9] that intrinsic reward and internal locus of control will enhance learning outcome. Children who feel autonomous in their learning, develop self-confidence while learning, get better in reflecting upon their learning goals and results, appreciate learning more and feel more motivated to fulfill learning activities. This approach is named Self Determination Theory (Ryan & Deci, 2000).

So, the activities must be designed to cover all fields of the curriculum and additional skills, such as the skills that are known as "twenty-first century skills," and at the same time cover the four didactical types of work. Also, the activities must be repetitive, in order to allow for children or students to time their learning activities individually. For instance, if a specific content area is only offered in spring, children or students who want to study this area in autumn, will not be able to do so. Therefore, the offering of lessons should be year round and if possible also repetitive in 1 week.

[9] See: De Brabander and Martens (2014). Winner of the biannual EARLI outstanding publication award 2015.

Getting Rid of Obstructing Mind-Sets: Farewell Constant Monitoring

A second important mind-set shift that teachers have to make is to let go of the reflex to monitor the process on a daily basis. Using adaptive software means that the learning progress is already monitored in real time by "machines"; no need for the human brain to duplicate this effort. In our schools, every 6 weeks, children (and their parents) discuss their personal development plan (PDP) with the coach. Every teacher serves as coach for 20–25 children, and mapping out the individual learning paths is an important aspect of this role. [10]

The other role of the teacher is the role of specialist. The specialist typically works in a subject specific studio: the math room, the language room, the creative room, etc. Since the children hop from studio to studio, their learning experiences are not monitored on a daily basis by one and the same teacher. The team of teachers is responsible for valuable learning for all children during the day; but it is too much to ask to keep in mind all the progresses of the maybe 100 children a specialist might interact with in 1 day.

Therefore, the progress of children is monitored by software, and evaluated only every 6 weeks (or any amount of weeks that seems fit). We see that this is a tough one for many education professionals. They feel they are operating in the blind; not knowing if children learn seems to equal children not learning. But this is obviously a misconception. If a school creates a culture of hard work, and if the professionals (and parents) do not allow idle chatter or nonproductive play, one must assume that learning progress takes place.

Of course, a theoretical possibility remains that a specific child manages to avoid learning activities to an extent that it threatens progress. It is important to stress that this is not very likely once we grant relatively much autonomy to children. But if it happens, a child has avoided for instance math for a period of 6 weeks, it can only mean that this child must make up for this in the next period. The coach can schedule obligatory activities, while resorting to the didactics that have an external locus of control.

Getting Rid of Obstructing Mind-Sets: Welcome Parents

The third important mind-set shift teachers have to make, concerns the ownership of the learning. Once we acknowledge that we cannot monitor the learning process on a daily basis, it is important that we transfer the responsibility for the progress largely to the child or the student. This requires trust from the teacher and leads to a sense of autonomy of the child or student. Now of course, we can easily see the boundaries of this shift in responsibility: education is asymmetrical in the sense that the teacher

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[10] See: http://issuu.com/bookshelf/docs/de_gang_van_zaken_op_de_fysieke_sch_80e6f03a5bc962.

knows what there is to learn, and the pupil can be "unknowingly unknowing." So, the teacher has already climbed the top and appreciated the view, while the pupil has a certain resistance towards the act of climbing.

To grant full autonomy is counterproductive; not only does the pupil not know what the rewards will be once the skill is mastered, but also the overview of the whole competence or field of knowledge is necessarily incomplete. This being said, to return the ownership of the learning process to the child or student is a very productive intervention. If we take a close look at the metaresearch that John Hattie carried out over recent years, the conclusion is just that of all possible interventions in education, those that have to do with expectations of, reflection upon, and autonomy in learning are the most fruitful to learning effectiveness (Hattie, 2008). In other words, schools who want to improve the efficiency of their efforts, ought to start with giving back the learning process to the rightful owner: the child or student.

In primary education, ICT and especially social media have an important role where they tie parents to school and make them an integral part of a learning community. Parents are not involved in school, they *are* the school as much as children and teachers are the school. This is an important aspect of our schools, since we transfer the responsibility for the learning process from school to the owner; but if the owner is too young to live up to this responsibility, it is delegated to his or her parents. In order to take this role (almost all parents are very willing to!) parents must be enabled to be "in" school, not only in the flesh, but also through virtual presence, i.e., through social media. Children are to take a picture or make a screen dump of every meaningful learning activity, which can be shared immediately with parents in a temporary portfolio. In this way parents get a good view of the day to day school activities of their children; from the black box it usually is, school develops into a collaborative effort of parents and teachers. Also, an important aspect of Steve JobsSchools is that parents play an active role in the education itself; they deliver workshops or lessons or supervise enterprises or research projects. The disadvantage of the possible lack of didactically or pedagogical skills is relatively small compared to the enormous advantage of tapping into a huge amount of expertise in a wide variety of fields.

To sum it up, apart from the totally new way learners learn if they can use digital tools, deploying portable devices such as iPads or Chromebooks makes way for a totally new organizational model of the school. This is important to make the century-old call for personalization that Helen Parkhurst and Maria Montessori formulated come true.

Educational Software Personalises Learning

The second part of this contribution will be directed to the "virtual school," i.e., the school that resides in the one on one device. The 1:1 aspect is important; carrying ICT hardware in schools is far less powerful than 1:1 deployment of devices. This is shown in a comparison of PISA-scores in an OECD-study that focused on the effectiveness of computers in education (OECD, 2015). The data in this study were derived from the field before 2012, that is, before the rather massive introduction of 1:1 iPads and Chromebooks in education. The overall conclusion of this survey was that adding hardware to a classroom has little to no positive effects. But we notice in Steve JobsSchools that the results on old-fashioned indicators are not worsening, while our children perform much better than peers in "analogue" schools in tasks that are typical for interactive digital learning. An analysis of test results of our school in Amsterdam shows that learning outcome (expressed in test results on reading skills and mathematics) is 1.4 times the benchmark. Note that the ability of children plays no role, since the measure is: months of growth, not the proficiency level itself. Also, social skills improve remarkably.[11]

So, in order to evaluate the merits of computers in education, we must rephrase this question to: what are the benefits of the one on one deployment of portable devices in education?

These are: adaptive learning, accessibility of learning sources to suit individual learning styles, and internal pacing of learning.

Adaptivity

There are two models of adaptiveness of educational software. The first is to use levels. The student is stuck at a level until he masters it. An example of this approach is Khan Academy; once the student can provide five correct answers in a row, he gets promotion to the next level. The second model is more subtle. Questions and players are seen as opponents and get a rating based on analysis of the results. The algorithms at work determine how hard a question is based on thousands of entries by players whose level is known since they have tried millions of questions. With this established, the software can offer questions at a level that suits the student; the student himself can even choose hard, medium or easy questioning, in other words, pick a percentage of wrong answers. Also, certain domains can be shut off if a student tends to neglect certain other domains; in order to work in the favorite domains, the student must complete a minimum amount of the not so popular subjects. This approach is used by the tools Math Garden and Language Sea, among others.

Abundance

If a school deploys one on one devices, the students can pick from a wealth of available resources online. This makes fine-tuning in learning possible, since every student works in the software environment he or she prefers. In a world where basic

[11] A quantitative tool for this assessment is in operation, but the longitude of this measurement prohibits us to present "hard" data. This claim is based on numerous reports of parents, both in face-to-face contacts and in blogs.

information is retrievable within 5 s, learning stuff "just in case" does not make sense; students prefer to learn "just in time," and this does make sense. Rather than concentrating on creating a common knowledge base, education should focus on information processing skills, critical thinking and creative ideas. The concept of "find, filter and apply" as the very center of our education effort is crucial in most of the pleas for redefining education.

We now have access to a great wealth of knowledge anytime, anywhere. Conrad Wolfram provided a compelling argument for this in a Ted Talk in 2010.[12] 50 years ago, there was no device that could compute the square root of 53; so we learned how to calculate this. This consumed a whole lot of learning time, time that could not be spent on learning to conceptualise and apply mathematical principles. Now that a smartphone has more calculating power than a mainframe computer 20 years ago, the educator's time is better spent if we focus on conceptualization and applying mathematical concepts. Also, education served as the phase in a person's life that prepared him or her for the future; the knowledge base that fits in one brain was sufficient to cope with life's challenges. Since our society became more complex and our careers more versatile, learning has evolved in a lifelong duty. The importance of the "what" of learning has therefore decreased, and the 'how' has become more important. If all knowledge is available, and we learn during our whole life span, it becomes futile to focus on a common knowledge base in the brains of all 18-year-old citizens. We face a shift from *just in case* learning towards learning *just in time*; I need knowledge for achieving my goals, so I gather, evaluate, and apply the knowledge (Kagan, 2015).

This does not mean that children and students are to neglect the more basic levels in Blooms taxonomy (Engelhart, Furst, Hill, & Krathwohl, 1956): knowing and understanding. But what is does mean is that these basic levels differ from one student to the next; where one student learns thousand of words in a foreign language, the next student may learn 1000 other words or 1000 words in another language; moreover, one student may learn 500 words this month, the next student may learn 5000 new words …. The common base of knowledge that is so crucial in most curricula is outdated; in the new networking society, the opposite is more desirable, namely if individuals have different bodies of knowledge. The abundance of online resources makes education a totally new gameplay.

Pacing

The third aspect of digital learning is that it allows for individual pacing. If lessons are canned on YouTube or Vimeo, and practice is scheduled in an individual schedule rather than in a group setting, students can fast forward or rewind just as they please. This might make the explicit and formal learning far more efficient for any student who is not on the exact median level. This gain of time can be invested in the more rewarding types of work, for instance, work in enterprises or own research. [13]

[12] https://www.ted.com/speakers/conrad_wolfram.

[13] This is discussed in: The Educational Technology Anthology Series (1991). There is not a whole lot of empirical evidence available.

Not Only Highly Desirable, Also Workable

We face resistance to these very desirable aspects of our educational concept, and most of it doesn't focus on the principles but rather on perceived practical impediments. People fear that students who are offered trust will abuse this trust. They will spend many idle hours instead of learning, nobody will know if education fails or succeeds, it will be an organizational nightmare. But the opposite proves to be true, once you give it a try. We had to develop planning software and we are currently working on some other software tools, but in our schools children are happy, parents are content,[14] and teachers are thriving. School in this way truly has become a learning community and a lot of social and emotional problems that we have got used to in "normal schools" are nonexistent.

An instrument called sCoolTool is what makes school happen; with it, teachers broadcast their offerings and children plan their day. If the children are too young to make sound decisions (choose activities based on their learning goals) their parents are helping them to plan their day. The portfolio that proves they are progressing is directly attached to the activities; so even very young children can keep track of their progress. As stated above, learning awareness is proven to be the single most important intervention for teachers wanting to enhance the effectiveness of education.

Children only see activities on their screen that are relevant to them. Some items are obligatory, but most often every time slot has a variety of activities that they can choose from. This enables children and students to focus on their own talents, or to put more effort in goals they find hard to achieve.

When asked what aspect of the Steve JobsSchool students liked most, almost none of them answered: the iPad. The vast majority of the children named the freedom to choose the best thing of school in comparison with previous schools. Justifiably the children do not emphasise the digital tools; they value the organizational gain that these tools enable. A survey conducted by the University of Amsterdam showed that the involvement of children in a Steve JobsSchool was considerably higher and their learning experience was more positive (Neto Gomes de Almeida, 2015).

It is important to stress that Steve JobsSchools have to meet the demands of the national curriculum. So where we might question the relevance of some parts of it, we comply with the common core of knowledge and skills that our children have to acquire to make national grades. But we do so much more: the twenty-first century skills, the work on individual talents, extracurricular areas as programming and robotics …. All of this is possible due to the efficiency gains that personalization brings about.

For schools that want to fully benefit from the organizational and educational advantages of applying digital technology, we have a precise roadmap available.

[14] On our flagship school in Amsterdam, the satisfaction levels on almost all dimensions were at least half a point (on a 5-point scale) higher than the national average. E-mail for the full report: info@o4nt.nl.

The tools that we will gladly share are not confined to the Dutch educational system; Steve JobsSchools have opened in Spain, South Africa, and will most probably open in 2016 in several other countries. Especially after the influential blog Tech Insider named the Steve JobsSchool one of the 13 most innovative schools in the entire world, we expect a further international rollout.

In conclusion, both the organizational and the educational aspects of school are turned around if schools are willing to reconsider the goals, the means and the practicalities of their core operation. In our experience innovation that is applied only gradually have a high risk of failure; in the twilight zone between applying old practices and using new tools people easily get lost. Since education is a people's business, the gradual transition model is a risky approach. Schools that want to adopt our model, are advised to prepare thoroughly and then act quickly; the transition itself should be as short and sharp as possible. In the first year that a school operates in the new concept, the team should be curious and the headmaster stubborn.

If schools are willing to reinvent themselves, they are doing their children a huge favor—they prepare them for the future, not the past.

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Chapter 19
Technology to Improve Assessments of Learning in Class, School and Nation

Elizabeth Hartnell-Young

Abstract This chapter considers the current education policy context in Australia, including the high level of technology provision and use and an increasingly national approach to curriculum, teaching and assessment. It argues that to meet the first Professional Standard—"know students and how they learn"—teachers can be strongly supported by assessments conducted through technologies. The view of assessment in this case is not one of ranking and sorting, but a growth mindset, where teachers see their role as enabling learners to demonstrate growth over time. It describes elements of a Learning Assessment System to support this growth, and how technology assists teachers by providing feedback efficiently. It includes examples of schools working with researchers, government and industry to implement assessment tools that meet their needs. Finally it argues that while teachers must take a position regarding the purpose of assessment and play a role in the developments involving technology, the scope of the task is so great that it requires collaboration locally and globally.

Keywords Assessment in Australia • Growth mindset • Teachers' role • Education policy • Australia • Technology provision • Approach to teaching • Assessment • Curriculum • Online assessment • Teachers • Educators • Professional standard • Educational research • Learning assessment system • Researchers • Government • Industry • Individual needs • Collaboration

For those of us who have spent many years working with teachers, learners and technology, it may seem that little progress has been made in harnessing the promised benefits of technology for learning. In past decades we understood that access to devices and infrastructure was an important factor, so governments determined that schools would have a range of hardware and software resources for teaching and learning and administrative use. Knowing too, that professional development for teachers was an important factor in introducing educational change, many programmes were offered, both face to face and online, device-focused and

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pedagogy-focused. Policy documents and curriculum statements were produced to encourage and evaluate digital learning. Many teachers used various technologies enthusiastically with their students. Yet as the 2015 Horizon Report noted, scaling up innovation remains a "wicked challenge" (Johnson, Adams Becker, Estrada, & Freeman, 2015, p. 1).

This chapter considers the current context in Australia, a long-standing federation of states and territories, which is moving towards a national approach to major aspects of education policy. It focuses on how teachers are using technology to better know their learners through assessment approaches at local and broad scales, and provides a model to support an emphasis on growth rather than rankings.

Assessment is a term not always loved by teachers. In fact I've been told by teachers "assessment was one of my least favourite subjects at university", and "everyone hates it because it's very boring". Perhaps this is because it seems to have been taken out of teachers' hands, although it is an essential part of teaching. In this chapter, I argue that assessment involves recognising and valuing what people know and can do in relation to a broader context of what is possible. This is in line with the view of Masters (2013) who says "the fundamental purpose of assessment is to establish where learners are in their learning at the time of assessment". He goes further to argue that this means that distinctions between "formative" and "summative" assessments are only related to their use, not their format. A test can be used for both formative and summative purposes, as can a music or drama performance.

The collection and aggregation of assessment data is showing us the detail teachers often suspected. When children begin school they are already likely to be spread over a wide range of achievement levels. In Australia in reading and mathematics, students commence each school year with performance levels across a range of about 5–6 years. And in spite of this evidence, educational policy and school organisation appear to assume that the vast majority of students of the same age are at similar points in their learning and development. This creates a challenge for teachers who are expected to have all their students meet certain standards. A handful of schools are attempting to organise differently, but they are in the very early stages. The examples in this chapter, several drawn from the practitioner conference "Excellence in Professional Practice" held annually in Australia (ACER, 2015), show how technology is assisting teachers to monitor and assess learners. However they also reflect the scope of the task, which goes beyond what individual teachers can achieve and is best tackled by teachers working together, often in conjunction with researchers, education departments or industry to improve student learning.

The Australian Scene

Policy Context

The "Melbourne Declaration" made by all education ministers of Australian states and territories (MCEETYA, 2008) is the current statement of goals for education in Australia. There are only two goals:

1. Australian schooling promotes equity and excellence.
2. All young Australians become successful learners, confident and creative individuals, and active and informed citizens.

To be successful learners young Australians are to be creative and productive users of technology as a foundation for success in all learning areas. The Declaration identifies essential skills for twenty-first century. It describes individuals who can manage their own wellbeing, relate well to others, make informed decisions about their lives, become citizens who behave with ethical integrity, relate to and communicate across cultures, work for the common good and act with responsibility at local, regional and global levels. This document underpins the Australian Curriculum, the first national curriculum since Federation in 1901. In addition to the major disciplines, the curriculum includes seven "general capabilities": literacy; numeracy; information and communication technology capability; critical and creative thinking; personal and social capability; ethical understanding; and intercultural understanding (Australian Curriculum Assessment and Reporting Authority, 2013).

With regard to teachers, Australia has developed professional standards that commence with "know students and how they learn" and include "know the content and how to teach it", "plan for and implement effective teaching and learning" and "assess, provide feedback and report on student learning" (Australian Institute of Teaching and School Leadership, 2014). These standards outline the roles of teachers, and remind us that what students bring to the learning is the starting point for teaching and by implication, personalised learning. Yet Johnson et al. (2015) lament that the potential for personalised learning is constrained by the pressure on schools to perform on standardised assessments. Since it is unlikely that standardised tests will be discontinued readily, it is important to develop ways in which local knowledge and local assessment can provide immediate and ongoing understanding of learners, and to see standardised tests as more general information based on particular points of time. Both have value, for different purposes.

Technology Provision and Take Up

Australia has a history of technology provision for education and Australians generally take up technologies with alacrity. For a population of 21 million, from 2008 to 2012 the Australian Government invested $AUD2.2 billion (£1b plus) in high speed broadband, devices for secondary students in Years 9–12, and online learning resources, through its Digital Education Revolution. Australian schools are therefore quite well resourced (DeBortoli, Buckley, Underwood, O'Grady, & Gebhardt, 2014). On average, the ratio of students to computers is three to one, compared to the international mean of 18 students per computer. An increasing number of students bring their own device to class, or have access to a class set of portable computers. Australian students are frequently using technologies outside of school. Students have reported that they most often used technology to build and expand on "what the teachers are teaching", to communicate with other students and discuss the learning content, and to "learn other things at the same time as learning what is intended" (Moyle, 2010, p. 37). However, many of these same students reported that when in school they felt that they were stepping back in time. Moyle argues that rather than being due to the technologies available in schools, this is more a result of how the technology is used in class.

Almost all Australian Year 8 students surveyed for the International Computer and Information Literacy Study (ICILS) in 2013 had access to tutorial software, digital learning games, word processing and spreadsheet software, multimedia production tools, presentation software, communications software and graphics or drawing software (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014). The proportions of students with access to data-logging and monitoring tools (85 %) and simulation and modelling software (85 %) were much higher in Australia than in any other country, and substantially higher than the international means (54 % and 41 % respectively).

Another recent report (OECD, 2015) confirms the high level of access by Australian students. Yet in the fairly narrow measures of the Program for International Student Assessment (PISA), recent cohorts of Australia's 15-year-olds are not performing better than previous cohorts, and in fact are reaching lower scores than before. Increasingly, there is a realisation that it's not a matter of merely providing devices, but how they are used by teachers and learners. Further, it is important to consider not only actions, but also teachers' beliefs that impact on the way they incorporate technology into their teaching. Dwyer, Ringstaff and Sandholtz (1991) found that for successful change, teachers needed opportunities to reflect on their own beliefs about learning, and that given structural support, these can change whilst in the midst of reform.

Approaches to Learning and Assessment

As an alternative to the hard-edged standards approach, Dweck's (2006) work on mindsets has become influential among teachers in Australia, with many accepting as a matter of principle that their role is to support students in their growth and development: "a growth mindset". Rather than starting with the assumption that individuals differ in their ability to learn (a "fixed" mindset), a growth mindset begins with a belief that most, if not all, people are capable of making learning progress if they are engaged, motivated, willing to make an effort, and provided with relevant learning opportunities. To do this, teachers not only need to know where their learners are in their learning, but also how they can target teaching to move students to further learning (Goss, Hunter, Romanes, & Parsonage, 2015). Clearly this is in contrast to a widely held view in some circles that assessment exists to rank and sort children, schools and nations. However accepting the Dweck argument can be a challenge, as it allows for no excuses.

Dweck's argument is supported by research in neuroscience that shows that most learning builds on existing learning, and that learning can be lifelong. Bruno della Chiesa, the instigator of the OECD project that led to the publication *Understanding* *the brain*: *The birth of a learning science* (OECD, 2007), suggests that educators need to keep two crucial ideas in mind: brain plasticity and the recognition of sensitive periods in human development (Australian Council for Educational Research, 2013). Plasticity refers to the discovery that 90 % of the neuronal connections (the synapses) are not developed at birth, but develop through life. Connections in our brains are activated as we recognise and link to previous learning, making it very important for teachers to continue to know their learners by conducting regular formal or informal diagnostic assessment activities.

In his theoretical model that can apply to all domains, Masters portrays the processes required for a connected approach, in a Learning Assessment System (Masters, 2013, p. 33). The purpose of the assessment system is to inform teaching and learning, and the five elements are:

- An empirically based learning domain
- Domain-appropriate assessment methods
- Task rubrics for recording observations
- Evidence-based conclusions
- Feedback

The first step in assessment is to specify the learning domain to be assessed. But Masters goes further to argue that the specification and description of the domain must be based on empirical work and firmly grounded in research into the nature of learning within the domain, which can be a specific discipline area, like history; or narrow fields within the disciplines; or one of the general capabilities or competencies that cross disciplines. The intention is to describe learning progress within a domain, rather than only listing learning outcomes.

The second step acknowledges that the assessment methods must be designed to provide useful information about where learners are in their learning within the domain. Different assessment methods are valid for different kinds of learning. Third, task rubrics for recording observations must be specific to the task, hierarchical and qualitatively defined. This means that rubrics are not generic, but must relate to a specific assessment task. Hierarchical rubrics are criteria or marking guides that contain several levels, each higher level including the description of those below. They are most useful when the characteristics or qualitative differences of each level are clear to the learners and assessors. Fourth, evidence-based conclusions should be drawn with reference to an explicit, empirically based understanding of learning progress within the domain. Deep knowledge involves professional training, experience and research. Finally feedback can be given and received.

Teachers in Australia are influenced extensively by the work of Hattie (2009, 2015), particularly on feedback. In his meta-analysis of research into factors affecting student learning, feedback was shown to have a significant effect size of 0.73. Most everyday feedback comes from teachers, in the form of a smile, a rebuke, a grade, a verbal or written comment. It can be immediate or delayed, depending often on the format. However recent work on intelligent tutoring systems and computer adaptive testing is providing instant feedback to students. A most important form of feedback is from students to teachers, which Hattie (2009) calls "Know thy impact", and this is where technology can be very helpful. Students generate digital data on a daily basis in their online interactions through learning management systems and use of devices. These data are the basis of work in educational data mining and learning analytics. For teachers, quantitative data collected through student activities and assessments can be presented in visualisation software to make individual performances and patterns visible, providing the information teachers need to plan the next steps for learning. There are numerous tools on the market, both subject specific and general.

A project undertaken in Australia's Science of Learning Research Centre is researching how to optimise feedback in interactive learning environments. Specifically, the project is exploring what kinds of feedback work best for learners of differing ability. The study uses behavioural and neural research methods such as observation, computer log data, eye tracking, biometric data and electroencephalogram (EEG) to examine the neural responses to feedback when students are using intelligent learning environments. Clearly the findings of these projects will assist teachers, but are beyond what most can undertake themselves.

New Technologies and New Literacies

The growing use of new technologies is requiring new ICT capabilities, including new skills in reading, communicating, online searching, and problem solving for a world in which employment opportunities are increasingly based on new knowledge and skills. The term "new literacies" can encompass visual literacy, critical literacy, scientific literacy and multiliteracies (Brown, Lockyer, Caputi, & Tognolini, 2010; Hartnell-Young, 2007). Assessments of aspects beyond the common areas of literacy and numeracy include assessments of ICT skill itself (Fraillon et al., 2014) and constructs where ICT is an integral part, such as digital reading (OECD, 2011) and problem solving (De Bortoli & Macaskill, 2014; Griffin & Care, 2015).

In line with the goals for learning, ICT Literacy—accessing, managing, integrating and evaluating information, developing new understandings, and communicating—is measured in Australia's National Assessment Program (NAP). Sample surveys are conducted on a rolling triennial basis at Year 6 and Year 10. The most recent figures show that the skills of Year 6 students are increasing, while at Year 10 the level of skills is relatively stable (Thomson, 2015). At the national level, female students significantly outperformed male students in the NAP-ICTL assessment at both Year 6 and Year 10.

There are calls for assessment reform and renaissance, with some authors suggesting that current assessment methods need to be replaced, and that technology will play a larger role in the future (Hill & Barber, 2014; Masters, 2013). As new literacies or general capabilities develop throughout the years of school, assessment processes must be capable of monitoring students' long-term development. We will need to underpin assessment with knowledge of what long-term improvements in these skills, attributes and understandings look like—that is, by learning "metrics" for monitoring progress over time. How are teachers to respond? Clearly not individually, and possibly not even as teachers alone. More and more, teachers are collaborating with researchers to engage in systematic inquiry around issues of professional practice. In a project designed to assess "multiliteracy", researchers developed and tested a conceptual model in conjunction with practitioners, using an online assessment (Brown et al., 2010; Buckley-Walker, Tognolini, Lockyer, & Brown, 2015).

Australia has been involved in the leadership of the Assessment and Teaching of 21st Century Skills (ATS21C) project and researchers at the University of Melbourne have developed a range of assessments to identify collaborative problem solving (between two human learners, rather than placing a learner with a computer agent as the collaborator). The trial tasks relate to curriculum domains such as mathematics and physics as well as general capabilities. Based on the principle that each learner has different information that must be combined to solve the problem, the data logs created as the two learners share their information provide measures of cognitive and social skills on a continuum of growth (Care, Griffin, Scoular, Awwal, & Zoanetti, 2015).

Even if assessments are presented in the form of tests, the range of possibilities is much broader than the typical multiple choice format. Tests now incorporate dynamic texts, such as video, animation or audio. As well as using a mouse to click on an option, or typing words or numbers, students can record responses orally, or drag and drop an object from one place to another, or click on a hot spot. This can lead to greater engagement and can enhance validity by isolating the skills being assessed, which are often mediated by, for example, students' reading levels or writing skills. For reasons such as these, a large-scale project in the Department of Education and Training in New South Wales, Australia (Sim, 2015) provides online multimedia interactive assessment items in science for a diagnostic test at several year levels, mapped against an assessment framework aligned with national and state curriculum. Work has started to expand the project to English, mathematics and history.

Interactive learning environments, such as simulations, can be used simultaneously for teaching and assessing, and are often used in science (Timms & Lodge, 2015). They can represent phenomena that would be hard to observe in a classroom, and allow students to safely use virtual equipment to conduct experiments. But a major benefit is their capacity to monitor students' decision making and other interactions with the system. Assessment can be embedded in the tasks and evaluated immediately within the system, giving feedback to the learners as well as to the teachers. Research shows that reliable judgements about learning can be made using these tools, but Timms and Lodge caution that due to the time and effort required, they should only be used for assessment that is difficult to undertake in other ways.

The Roles of Teachers

Teachers recognise that they are at some times learners too, engaged in co-constructing knowledge with their students. While much of the large-scale development work described above will not be undertaken by teachers, they should be aware of and contribute to means of assessment that can assist their teaching. Moyle (2010) suggests that technologies provide an opportunity to rethink the way educators work. While Johnson et al. (2015) consider rethinking the roles of teachers as a difficult challenge, the author has found in empirical research that teachers were shaping their roles (e.g. Hartnell-Young, 2003, 2009) in light of access to technologies. One major role of teachers is ongoing monitoring and assessing, although the term assessment may not always be used to describe it. But the main focus for this role is to find out: What does this child know? What can she do? What should we do now to stretch the learning, even beyond what we are imagining? And when an activity or intervention has been planned and tried out, How well has it worked? Is there evidence of progress? While it is not possible to tackle this alone, it is important for teachers to understand what is possible, and what is occurring in the technology arena. To do this they need to work together, constructing knowledge with their students, with other teachers, with researchers and other interested parties.

A "rolling summit" on assessment reform and innovation, under the auspices of Australian Council for Educational Research (ACER) over recent years, listened to teachers and shared with them some of the trends in assessment, particularly in using technologies. One teacher said "technology has yet to really flower as a mode of assessment" and others felt it was used mainly for learning tasks, rather than assessment. Those who did use technology reported they could set a wider variety of tasks, often authentic or "real life". Teachers reported developing their own systems to use spreadsheets to record, collate and analyse assessment data, pinpointing areas of concern to inform their teaching of individuals or groups of students. They used tablets and cameras for coaching purposes and to record obvious progress for self, peer and teacher assessment. They established class community sites, and platforms and quizzes where teachers could give timely feedback. Some used adaptive testing and on demand assessments provided by education departments. Others provided continuous reporting to parents through a learning management system or through digital portfolios.

At a secondary school in New South Wales, teachers formed an assessment and reporting team representing each learning area and used a range of assessment tools to enable students to show their growth (Endicott & Gavin, 2015). After a successful implementation of the new approach to assessment in Years 7 and 8, it has spread to Year 9 and 10. One primary school in Melbourne, Victoria decided to improve mathematics learning and teaching, assessment and reporting through the creative use of technology. A whole-school approach to evidence-driven assessment was developed, using readily available software, while also working with industry to develop customised products (Sheedy, Cananzi, & O'Shea, 2015). The resulting personalised approach to goal setting and feedback is said to have increased student agency. Another primary school determined to lift the scores of students in the upper and lower quartiles of achievement on standardised tests in reading comprehension (Blakey, Darvell, & Holmes-Smith, 2015). As well as implementing professional development and specific teaching strategies for reading, the school worked with the University of Melbourne and a small software company to identify where students were placed on a reading continuum, and used progressive achievement tests to gauge each student's Zone of Proximal Development (Vygotsky, 1962). After 3 years, students were showing growth on internal and external measures.

Some schools work closely with their education systems. With the introduction of the Australian Curriculum, many schools in Western Australia looked for a systematic way to collect student data. A not-for-profit association worked with the Department of Education to investigate teachers' needs and develop solutions. Over one hundred primary schools in Western Australia now use a Maths Tracker Monitoring Tool that includes teacher judgement data and covers the range from Kindergarten to Year 10. The tool creates data pictures of individual students as well as groups (Wright & Julian, 2015).

These examples show teachers taking the initiative to use technology tools to better know their learners as well as to realise efficiencies by working together and aggregating data.

Conclusion

With the attention given to curriculum and pedagogy in recent years, it is certainly time to turn our attention to the third part of the trinity: assessment. The approach to addressing assessment issues should include elements of top down support (from governments and large companies, for example) and bottom up action (by schools and teachers). Technology can assist teachers and learners to better know what progress they are making, individually and en masse. But teachers' beliefs need to be acknowledged as they are essential to successful reform. If we are to scale up innovation, involving teachers in the process, teachers must be clear about what they want to achieve with assessment tools, and take this opportunity to collaborate in projects as described in this chapter, share their experience and become involved in decisions that are made.

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Chapter 20
The Effect of Combining 1:1 Computing, Interactive Core Curriculum, and Digital Teaching Platform on Learning Math: The Case of a Charter School in New York City

Dovi Weiss

Abstract This chapter describes the effect of combining 1:1 computing, interactive core curriculum and digital teaching platform on learning math in one charter school in Brooklyn (New York City) during 2011 school year. The digital teaching platform that was developed by Time To Know is a platform that enables the teacher to plan a lesson and conduct it in real time, and to receive formative and summative assessment reports for data-driven instruction, including real time progress and performance of each student. A collaborative case study was conducted that examined the impact of T2K program on teaching and learning practices and learning achievement in math among fourth and fifth grades at the school. Results show that teachers using the Time To Know program demonstrated significant growth in their effectiveness in differentiated teaching. Analysis of student learning achievement in math, as measured by the New York State (NYS) standardized test, indicated on a significant increase in percentage of students who have met the NYS proficiency level.

Keywords Case study • Computing • Mathematics • Educational reform • Access • Digital devices • Teachers • Students • Classroom • Research studies • Student engagement • Pedagogy • Digital content • Curricular resources • Digital teaching platform • Common core ELA • Mathematics curriculum

Introduction

Few modern educational initiatives have been as widespread and far-reaching as placing computer-based technologies into the classroom. However, most educational researchers and theorists believe that the full opportunities and benefits

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afforded by technology in schools have yet to be fully realised (Oppenheimer, 2003; Papert, 1996). One of the attributed reasons for the often limited impact of educational technology has been students and teachers limited and shared access to computers and other technologies. In recent years, “1 to 1 computing” has emerged as a technology rich educational reform across thousands of classrooms where technology is not a shared resource—but where all teachers and students have ubiquitous access to laptop or other mobile computing devices. Research from 1:1 computing initiatives to date have found largely positive results including increased student engagement, more student-centered pedagogy, increased availability and use of student resources and products, and modest increases in student achievement (Bebell & O’Dwyer, 2010). Despite these successes, one of the most common shortcomings of 1:1 computing programs has been the lack of curricular resources and aligned digital content (Bebell, Weiss, & Shahaf-Barzilay, 2013). Recognizing this, the Israeli based company Time to Know developed a full digital teaching platform aligned to the Common Core ELA and Math curriculum. Although Time to Know (T2K) is entirely directed by the classroom teacher, major elements of the program run on individual (1:1) student laptops.

The T2K program is dedicated to providing a comprehensive constructivist curriculum providing:

1. A variety of thematic units and modular components,
2. “Out of the box” implementation or customization by the teacher,
3. Adaptation to individual state standards and
4. Differentiated instruction to support different ways of knowing and learning.

To date, there have been approximately 350 Israeli and American schools that have experimented the T2K platform. Initial feedback and evaluation from these settings suggest a number of positive benefits. Notable educational benefits for early pilot participants have included paradigmatic changes in teaching practices, increased student motivation and increased student performance across subject areas (Rosen, 2011a, 2011b; Walters, Dede, & Richards, 2010). Building on these indicators of success, Time To Know launched a second-generation pilot program across selected New York City Public elementary schools beginning in Fall 2010. One of these schools was one charter school in Brooklyn. This chapter describes the effect of combining 1:1 computing, interactive core curriculum and digital teaching platform on learning math in this charter school during 2011 school year. This Brooklyn charter school will be referred in this chapter as “the school.”

Background

Though the school received an A rating from New York City Department of Education based on its improvement in Language Arts, Math, Science, and Social Studies scores for the 2008–2009 school year, Grade 5 did not exceed the district scores. There was a need for teachers to differentiate instruction to meet the needs of each student to further emphasise math vocabulary terms, mathematical writing, mathematical reasoning, problem solving and computational skills. One of the school teacher said, “I know kids learn best through differentiation, but implementing it is a whole other story.” Another teacher said, “I believe in it. I struggle in how to do it and to do it well, and efficiently. I understand the merit behind it.” An administrator commented, “I told the teachers that at the end of the year I want to hear that the students love math.”

According to New York City Department of Education December 2009 Renewal Report “many teachers plan lessons that engage students and actively involve them in targeted learning … high levels of rigor and classroom engagement were not observed consistently across all classes. Often the level of questioning did not promote higher order thinking skills, and in some cases teaching lacked rigor.” The report stated that the school is providing professional development in these areas to improve teaching and promote student engagement. One teacher commented, “Direct instruction is really hard for these types of students. It’s a lot of sitting and listening. I don’t think the kids learn best that way.” A school administrator said, “We’re working a lot with professional development in order to differentiate to meet all the children’s educational needs. We need to be able to work to have student progress and know where our children are to bring them to the next level.”

The Digital Learning Environment

In order to promote differentiated instruction and conceptual teaching of mathematics the school decided to implement the Time To Know (T2K) program using the advanced digital teaching platform (DTP) and a one-to-one computing environment in fourth and fifth grades.

The pedagogical vision of T2K is designed to empower the teaching, learning and assessment processes in order to: (a) turning diversity into an opportunity; (b) create a meaningful learning experience; (c) integrate assessment into teaching and learning; and (d) bring twenty-first century skills into the classroom. The main idea is to create a partnership between the teacher and the technology. T2K DTP is designed with a social-constructivist approach to learning and teaching (Fosnot, 2005; Prawat & Floden, 1994; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; Von Glasersfeld, 1995). The program consists of five main components (Walters et al., 2010; Weiss & Bordelon, 2012):

Infrastructure: one-to-one laptop environment with a workstation, projector and a whiteboard/interactive board for the teacher, all connected wirelessly to secure Internet access.

Interactive year-long content: Recommended sequences of interactive learning activities that are aligned with state standards. Teachers can modify these sequences by uploading their own “best practice” materials directly into the lesson flow. The curriculum also includes differential materials, allowing the teacher to simultaneously target all students while addressing their different difficulty levels, by providing content adapted to each level and to student learning pace. The materials also includes built in scaffolds, which the students' can utilise upon need (e.g., Text narration tool for written texts, dictionary etc.)

Digital Teaching Platform (*DTP*): A platform that enables the teacher to plan a lesson and conduct it in real time, and to receive formative and summative assessment reports for data-driven instruction, including real time progress and performance of each student. The platform also provides the teachers with the ability to address unique needs of each class, by creating new lessons, based on T2K's content repository or user generated content.

Pedagogical support: Every teacher who joins the program takes part in comprehensive ongoing professional learning experience, conducted by T2K's instructional coaches and designed to empower twenty-first-century teaching strategies and support teachers' adaptation to constructive teaching methodology.

Technical support: Personal and support call center combined with real time chat based support, ensures that the teacher will have the optimal, problems free, environment for conducting real time lessons.

The T2K program contains a structured Mathematics and ELA curriculum of guided learning sequences for elementary schools that includes open-ended applets and discovery environments, multimedia presentations, practice exercises, and games. For example, in Mathematics the teacher opens the lesson with an animation, which is used as a trigger for a specific learning topic, such as fractions. Next, a class discussion on the topic increases the curiosity of the students who then explore the topic and perform guided experiments individually using the fraction applet. The students then submit their work to the class gallery where the teacher projects the work and engages the students in a discussion which leads students to concept generalization. The T2K DTP was designed to present differentiated materials to different groups simultaneously and support diverse learning levels for the same topic. The class may be divided into homogenous groups of students with similar mastery level on a given topic.

The Role of the Teacher in a Digital Classroom

Today's kindergarteners will retire after 2065. It is hard to imagine what skills will be required of them to be happy, productive citizens in the 12 years they will be in school much less in the next 60. Who will prepare these children? Most of today's classroom teachers are digital immigrants. How well are they equipped to usher these children into their future? Today's teachers must be the facilitators that will orchestrate learning for tomorrow's students. Tapscott (1997) defined the changing role of the teacher as less of an "instructional transmitter … [but as] more of a facilitator of social learning whereby learners construct their own knowledge" (p. 148).

Teachers must possess the skills to understand and foster the critical attributes of a global, project-based, student-centered learning environment (Weiss & Rosen, 2011). They must be adaptive and willing to have students constantly creating their own learning while providing the structure to ensure that content is rigorous, and relevant to the real-world. New skills and competencies are required of students and the same is true for teachers. The variety of new types of literacy needed in the twenty-first century such as Financial, Media, Multicultural, Cyber, and Eco literacy are not the ones that digital immigrants have traditionally mastered. We cannot wait for a new generation of teachers to emerge. We must provide the tools, support, and structure that will assist our existing teachers as they reinvent themselves. Realizing the full likelihood of creating twenty-first century classrooms is a daunting challenge. Tackling this "impossible" challenge is exactly what T2K teachers are doing every day.

The role of the T2K teacher is being transformed in exciting and challenging ways. Providing today's teacher with the technology platform for the twenty-first century is the challenge that T2K is undertaking. Student instruction is guided by T2K teachers utilizing the Digital Teaching Platform (DTP) which organises all of the tools required for today's interactive learning environment. T2K teachers are systematically supported by their instructional coach. These highly trained, subject matter experts assist T2K teachers as they tackle one of their greatest challenges, creating a climate for student-centered learning. In this new learning environment, instructional planning takes on a fresh meaning. T2K teachers review student assessment data and determine which lessons will be placed on their digital bookshelf based on student needs and program scope and sequence. Additional instructional resources, such as videos, websites, PowerPoint presentations, and graphic organisers, that support the lesson flow, are selected from among the teacher's best practices and then uploaded onto the Digital Teaching Platform (DTP).

Differentiated teaching and learning refers to providing students with different ways to acquiring content; to processing, constructing, or making sense of concepts so that all the students within a classroom can learn effectively (Heacox, 2009; Levy, 2008). T2K teachers can use the DTP to place students into appropriate, dynamic learning groups so that activities can be differentiated as needed. Multiple teaching and learning modalities are accommodated as the teacher determines how each part of the lesson will be delivered. Converting teaching behavior from the traditional "sage on the stage" to intellectual facilitator is one of the new skills constantly encouraged and demonstrated by the T2K coaches. T2K teachers take on an active facilitator role as they guide students through each lesson. They encourage students to discover and construct meaning while continuously monitoring the lessons through real time alerts provided in the program. While the teacher receives the alerts on the teacher station, circulating around the room to encourage students and check for understanding becomes the norm for the effective T2K teacher.

The implementation of a DTP and integration of online curricula presents classroom management challenges for teachers. Lesson planning and delivering effective instructional strategies are topics discussed between the teacher and coach. With early monitoring and appropriate adjustments, teachers can quickly incorporate the tasks of setting up computers and starting lessons with minimum disruption. The blended instruction approach of the T2K curriculum requires that teachers practice routines with their students so that loss of instructional time is minimised as student's transition from on and off-computer activities. Collaborative group work is alternated with individual work and teachers need to not only tolerate, but learn to welcome, a certain amount of the noise and movement that accompanies an interactive learning environment.

Embracing lifelong learning is yet another role that T2K teachers confront as they close the gap between the digital immigrants and the digital natives. While the T2K curriculum can be utilised "as is," knowledgeable teachers will quickly want to utilise the many platform features that allow them to incorporate best practice materials and strategies into the prescribed lesson flow. In regular conferences with coaches and peers, teachers expand the horizons of the system. Participating in professional learning experiences (PLEs) promotes skill building and creativity. The twenty-first century student is not afraid to "jump in the deep end" and try new technologies and T2K teachers must be willing to do the same.

Teachers fluent in utilizing the T2K digital platform will also take on roles as change agents both for themselves and their students (Weiss & Bordelon, 2012). The biggest obstacle to changing how we deliver education to our students is the status quo. Some educators have not embraced the twenty-first century skills necessary to ensure that our students are productive and happy citizens. As our teachers become masters of utilizing digital teaching platforms, they will need to be advocates who promote the benefits of this new era in teaching and learning.

Evaluation Research

A collaborative case study was conducted that examined the impact of T2K program on teaching and learning practices and learning achievement in math among fourth and fifth grades at the school. The study allowed a comprehensive look at the program's educational effects, and factors that appear to have contributed program's success.

The research participants were: 39 4th grade students, 46 5th grade students, and their four Math teachers.

The goals of the research were to evaluate:

- *Math Knowledge and Skills*: Effects of T2K program on the school students' learning achievements—by using New York State (NYS) standardised test and higher order thinking assessment.
- *Teaching and Learning Practices in Classes*: Implementation of differentiated teaching, and impact on engagement and motivation—by using lesson observations, teacher interviews, and reflective diaries.
- *Attitudes and Perceptions*: Impact on students' and teachers attitudes and perceptions of teaching and learning—by using students drawings, surveys, interviews, and reflective diaries

Results

Differentiated Instruction and Conceptual Teaching of Mathematics

The conceptual framework to measure differentiated learning by indicators was based on Heacox (2009) differentiated learning strategies. Heacox defines ten indicators for differentiated learning:

- *Rigor*: Teacher providing activities that reflect intellectual engagement that requires learners to stretch beyond their comfort zone.
- *Modeling*: Teacher providing modeling, guided practice, and scaffolding.
- *Choices*: Teacher engaging students in choices based on interest in topic, process, or product.
- *Pacing*: Teacher demonstrating remediation or acceleration due to student progress
- *Adjustment*: Teacher adjusting the instruction in response to ongoing learning progress.
- *Planning*: Teacher adapting and planning for differences in readiness, interests, and learning preferences.
- *Technology*: Teacher incorporating appropriate technologies or technological tools to lead to mastery or enrichment.
- *Feedback*: Teacher providing descriptive feedback to the class on the learning process.
- *Self-management*: Teacher providing opportunities for students to increase their independence, responsibility and self-management.
- *Collaboration*: Teacher promoting collaborative learning among students.

Based on a yearlong case study involving observations of differentiated learning situations in the fourth and fifth grades at the school, in the areas of differentiated teaching and learning including rigor, choices, collaboration, adjusting instruction as necessary, and providing feedback and opportunities to build independence, teachers using the Time To Know program demonstrated significant growth in their effectiveness in differentiated teaching as shown in the following figures (Figs. 20.1 and 20.2):

In addition teachers are spending more time working with students individually. On average, 30.3 one-to-one teacher-student learning interactions were observed during Time To Know lessons, compared to 23.5 in typical conventional math lessons (60 min. lessons). Those interactions enable meeting student needs better than in whole class instruction. A consistent advantage for Time To Know was found in terms of teaching modalities during the lessons. On average, a variety of 6.1 instructional modalities were found, compared to 3.1 in typical non-Time To lessons. In the Time To Know classrooms, teaching styles have become less lecture-oriented and “constructivist” in nature, with more opportunities for students to actively construct their knowledge. Students are also working independently more often and in a richer context.

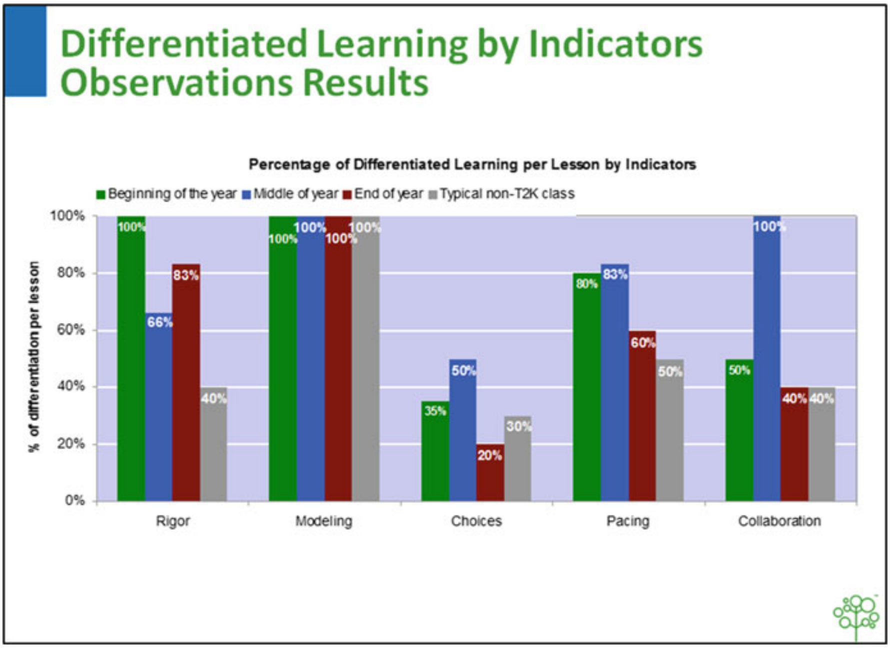


Fig. 20.1 Differentiated learning by indicators—observations results

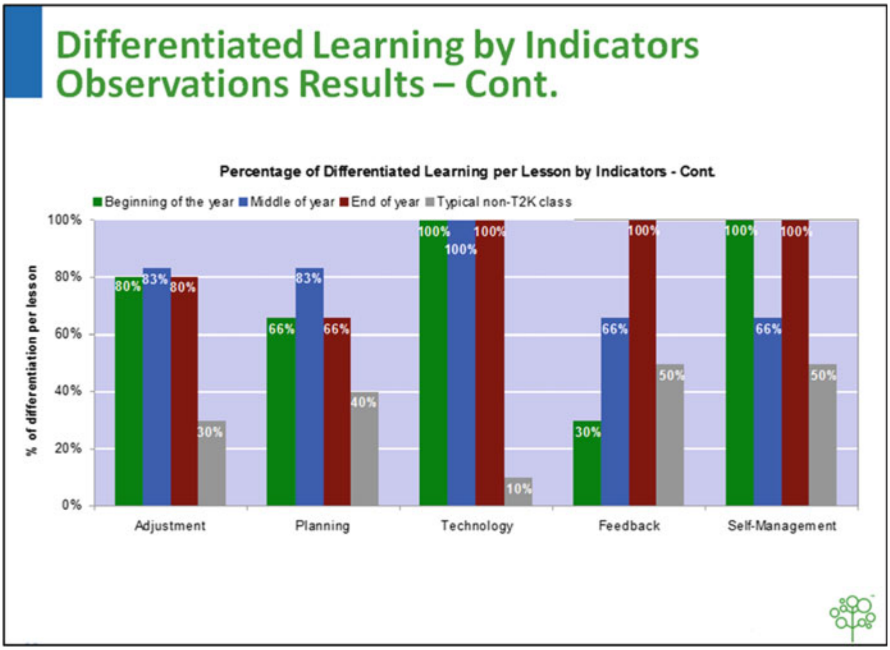


Fig. 20.2 Differentiated learning by indicators—observations results cont

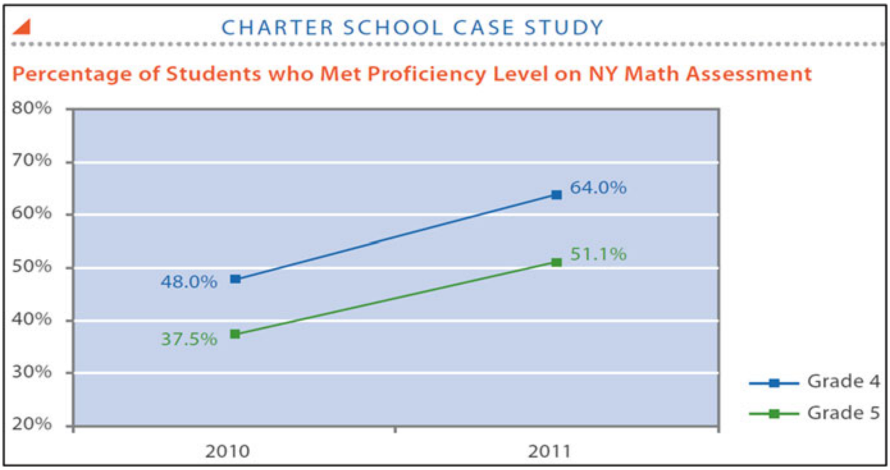
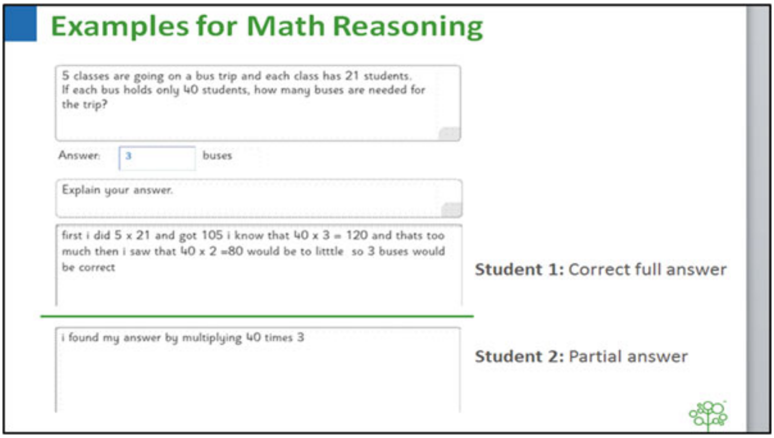


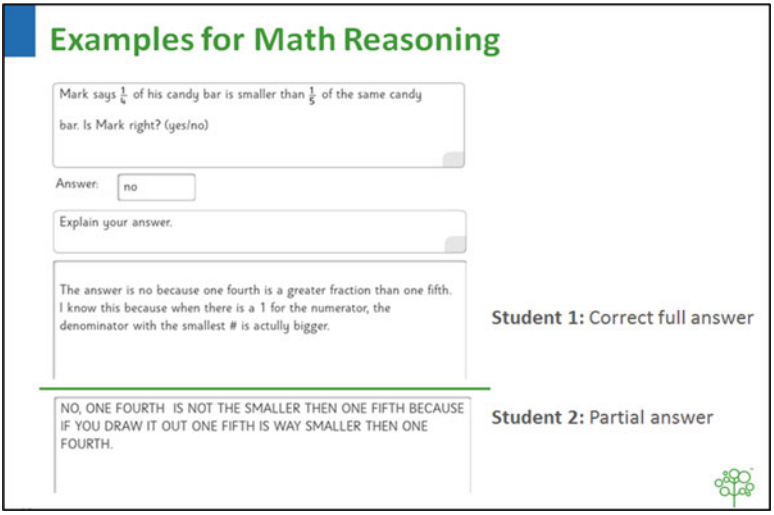
Fig. 20.3 Percentage of students who met proficiency level

Teachers commented: "One of the reasons I like Time To Know is that with a click of a button I can differentiate easily for the kids. It's a relief knowing that my high skill kids are getting challenged. I give those kids over to Time To Know and I know they're getting challenged. It's one less thing I have to pull out and do." A school administrator said, "Time To Know has really helped us focus and differentiate easier in math, which was an area we really needed to focus on. When I see the kids working independently and the teachers sitting with a small group, this is powerful. The kids are all engaged and the teacher has the opportunity to work with a small group. The engagement is tremendous." Another administrator said, "I feel like we're at the cutting edge. I like that. I feel that we'll meet the needs of the children of this generation. I like the fact that we're motivating all students to learn by differentiating. They like math. That's a big goal."

Further proofs of this effectiveness are the student scores on the state achievement tests. Analysis of student learning achievement in math, as measured by the New York State (NYS) standardised test, indicated on a significant increase in percentage of students who have met the NYS proficiency level, as shown in the following Fig. 20.3. 64.0 % of fourth grade students achieve proficiency in math, compared to 48.0 % before Time To Know (16.0 % increase). 51.1 % of fifth grade students have met the proficiency level in math, in comparison to 37.5 % before participation in Time To Know program (13.6 % increase).

In addition, assessment on math higher-order thinking skills with emphasis on reasoning and applying knowledge and skills (transfer) to new problems showed that learning in Time To Know program significantly enhanced students' higher-order thinking. The following figures show an example of a question focused on math reasoning and examples of students' answers.

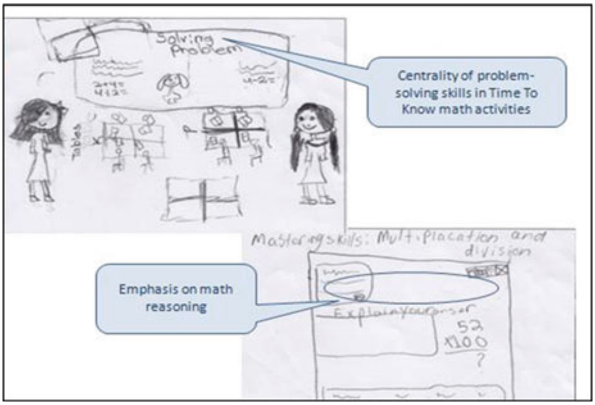


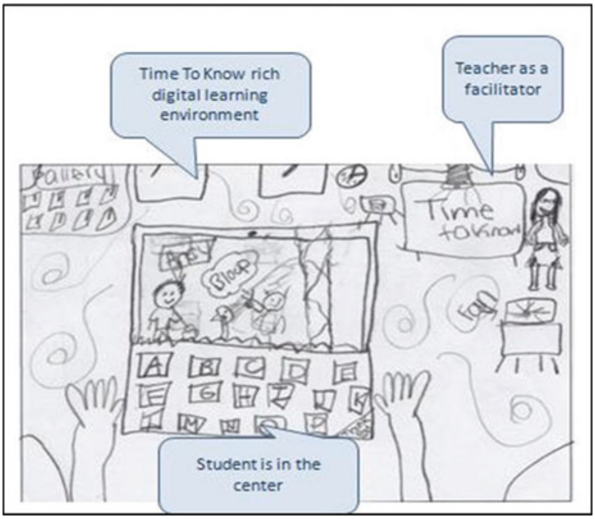


Teacher Empowerment and Student Engagement

An administrator said, "When I see the kids working independently and the teachers can sit with a small group that is powerful. The kids are all engaged and the teacher has the opportunity to work with a small group. The engagement is tremendous." A student commented: "Without Time To Know it's very confusing and it's not fun things. I work better with fun things and with it more explained. With Time To Know it's visual and you have fun." Another student said, "It's a fun and creative program to help us understand math better without the textbook and all the boring math."

Student drawings comparing math lessons before the implementation of Time To Know and after its implementation provide an interesting glimpse into student perception of the program and its impact on motivation and teaching practices.





Analysis of the interviews with the teachers reveals five themes that occur in the majority of the transcripts:

Promoting Engaged Learning

- "I feel that the students find the Time To Know to be more fun. It's not getting a text book or listening to a lecture. It's catered to them. They're the generation of instant gratification, so the computer engages them. The graphics, the problems, the graphics is more engaging for them. The first month they didn't realise they were doing math."

- "The textbooks are boring. The lingo is dry. Time To Know is more engaging. They can move and look and see. The kids take the initiative to ask for more work and to do more things. I like that. I can throw in some prior knowledge or games. They don't have that in the text book."

Visualization of Learning

- "Students enjoy the animation and some of the songs. I feel that it helps them remember and understand the concepts before working on the independent learning."
- "I like the new perspective that Time To Know shows. It's like a story and I like that."
- "It's different than the textbook. It is visual. Many kids like to see the visuals. And they see how it relates to everyday life."

Fostering Independence in Learning

- "The students work independently and I can keep track of what students are working on. I can see how many times the student tried to answer the question and whether they finally got it correct or not. My role is to facilitate the learning."
- "Kids are getting repeated practice. They're practicing with games. I don't have to tell them they're wrong. They can look at it and see if they're incorrect."
- "It's fostering a lot of independence and the inquiry aspect of it. It's encouraging the students to think and they're solving problems on their own."

Differentiated Learning

- "I can assess students and work in small groups—I was able to see how students were doing with a regrouping lesson and that allowed me to put the struggling students in a small group and work with them and re-teach the concepts."
- "Time To Know system reports allow me to see which students are struggling with specific topics that can help me differentiate instruction and re-teach using various methods."

Success Stories

"I have one student who was struggling with place value and regrouping. After teaching the concept in class using place value blocks, she still wasn't getting it. After watching the animation and working independently on Time to Know, she had a moment when she told me that she understood it now. I watched her complete some of the work and she did understand it. She did much better in class as well as during Time To Know."

"I have a really quiet little girl. The class was doing a review and she did the assessment and she told me that she didn't understand it. Her growth in math has really come up a lot. So we used the computer and she looked at the questions with me on the computer and she got a 100 the second time around. It was really nice to be able to sit right down with her and have the materials right there. She has really been working and she's really improving."

Conclusion

Conclusions can be drawn from these consistent and highly positive findings of the efficacy of the Time To Know program, suggesting a range of possible educational benefits that can be achieved through a comprehensive one-to-one computing educational environment in the US K-12 educational system. Teaching practices can be strengthened and improved, and more meaningful learning can bring a significant increase in student achievement and higher-order thinking skills. According to the US National education Technology Plan 2016 (US Department of Education, 2016), technology-based learning and assessment systems will be pivotal in improving student learning and will enhance educators' competencies and expertise over the course of their careers. This study provides empirical evidence for a meaningful and efficient education technology model that can potentially achieve these objectives in a complex educational context.

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Chapter 21
Improving Learning Through Stealth Assessment of Conscientiousness

Gregory R. Moore and Valerie J. Shute

Abstract In this chapter, we describe the importance of assessing and developing conscientiousness in students and how we are approaching this challenge. After discussing the benefits conscientiousness has for learning, we describe the process we are using to create a valid stealth assessment of conscientiousness. We then discuss the current state of this work and suggest next steps and areas of future research around conscientiousness. Finally, we broaden our scope to discuss the strengths and limitations of using stealth assessment to measure noncognitive competencies, as well as give some recommendations to help others use this approach. Our hope is that this chapter will demonstrate both (a) the importance and complexity of conscientiousness measurement in educational settings, and (b) a general process for thinking about and designing assessments for noncognitive competencies.

Keywords Conscientiousness • Personality • Stealth assessment • Game-based learning • Noncognitive competencies • Learning • Assessment • Students • Educational environments • Reflection • Assessment design

To succeed in modern society, students need to develop a wide variety of competencies (Partnership for 21st Century Learning, 2015), which are the knowledge, skills, and attributes that impact life outcomes. These competencies can broadly be divided into cognitive (e.g., math and verbal proficiency, problem solving, and reasoning) and noncognitive competencies (e.g., personality factors, collaboration, motivation). While cognitive competencies receive a lot of attention in the education literature, both are important for learning. Personality is one branch of noncognitive competencies. Previous research suggests that personality impacts many different life outcomes, including academic achievement and workplace success (Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). The Five-Factor Model of Personality has been a popular way to conceptualise personality for many years (McCrae & Costa, 1987). This model defines five broad categories of personality: Agreeableness, Conscientiousness, Extraversion, Neuroticism, and Openness. Of these personality factors, conscientiousness appears to be particularly important in education.

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Conscientiousness and Learning

Conscientiousness is a multifaceted construct that can broadly be described as the willingness to work hard and carefully. Attempts to define the precise facets of conscientiousness have resulted in a variety of factorizations of the construct. However, certain facets are consistently found in the literature: Persistence (sometimes referred to as industriousness or perseverance), Organization (sometimes referred to as order/orderliness), Carefulness (sometimes referred to as cautiousness or self-control), and Dependability (sometimes referred to as reliability or responsibility). Furthermore, research on perfectionism suggests it is also related to conscientiousness (Parker, 1997). Indeed recent factorizations of conscientiousness have included it as facet (e.g., MacCann, Duckworth, & Roberts, 2009). We therefore conceptualise conscientiousness with five facets: the four found in many factorizations of the construct (i.e., Persistence, Organization, Carefulness, Dependability) plus Perfectionism.

Research on the specific effects of conscientiousness suggests that it has positive effects on academic achievement independent from other predictors of academic achievement, such as past performance (O'Connor & Paunonen, 2007; Poropat, 2009). In fact, conscientiousness may predict achievement as much as intelligence (Poropat, 2009). Conscientiousness is also associated with higher effort (Noftle & Robins, 2007), improved learning motivation (Colquitt & Simmering, 1998), self-regulation (Abe, 2005), higher perceived ability (Noftle & Robins, 2007), fewer behavioral problems (Abe, 2005), and achievement learning orientations (Chamorro-Premuzic, Furnham, & Lewis, 2007). The relationships between academic outcomes and conscientiousness are seen throughout the lifespan, from early childhood and adolescence (Abe, 2005; Drake & Belsky, 2014) to post-secondary education (O'Connor & Paunonen, 2007; Poropat, 2009; Trapmann, Hell, Hirn, & Schuler, 2007). There are also relationships reported between conscientiousness and various workplace outcomes (e.g., Bajor & Baltes, 2003; Bakker, Demerouti, & ten Brummelhuis, 2012; Dudley, Orvis, Lebiecki, & Cortina, 2006).

The persistence facet of conscientiousness seems to be particularly important in education. Perry, Hunter, Witt, and Harris (2010) suggested that persistence, which they called *achievement*, drives the ability of conscientiousness to predict performance. Additionally, grit—a construct that can be considered as a combination of passion and persistence—has been found to predict a variety of learning and performance outcomes, including GPA, educational attainment, student retention, and spelling bee performance (Duckworth, Peterson, Matthews, & Kelly, 2007). Grit is also independent from intelligence.

The perfectionism facet has important implications for learning and performance as well. Research suggests that there are different types of perfectionism, which differently impact learning and performance. Hamachek (1978) suggested that can perfectionism can be broken down into two types. Normal perfectionists set high, but realistic, expectations of themselves, find enjoyment in their work, and are capable of accepting less than perfection. Neurotic perfectionists, though, set unrealistic expectations of themselves, struggle to find enjoyment in their work, and struggle to accept less than perfection. Throughout the years, researchers have tended to conceptualise perfectionism in a similar way, though with variations in terminology. For example, Terry-Short, Owens, Slade, and Dewey (1995) used the terms positive and negative perfectionism and Stoeber and Otto (2006) used the terms healthy and unhealthy perfectionism. In a similar vein, Parker's (1997) typology of perfectionism classified students into one of three categories: nonperfectionists (characterised by low standards and carelessness), healthy perfectionists (characterised by little fear of mistakes and good organization), and dysfunctional perfectionists (characterised by worrying about mistakes). In their review of the perfectionism literature, Stoeber and Otto (2006) suggested that healthy perfectionists achieve more, are more satisfied, have improved social skills, and are able to adapt to new situations better than unhealthy perfectionists. Furthermore, healthy perfectionists are less likely to experience anxiety, depression, and procrastination. Thus, encouraging the right type of perfectionism can help students in academic contexts and in life in general.

For all of these reasons, we want to help students develop conscientiousness, both globally and at the facet level, and provide support for students low in conscientiousness. To accomplish this goal, we need to accurately measure conscientiousness and its facets. While previous research on conscientiousness used self-report measures, these are problematic for three main reasons. First, people are often not able to accurately evaluate themselves, as it requires a level of self-knowledge that they may not have. Second, and similarly, respondents may interpret items differently. For example, if two people are rating their agreement with the item "I am tidy," they may have two different understandings of what it means to be tidy, which threatens the validity of the measure. Third, people tend to fall victim to the social desirability effect (Paulhus, 1991), presenting themselves more positively than they really are and/or more in line with what they believe the researchers wants to see. To resolve these issues and more accurately measure conscientiousness, we have been developing a stealth assessment of conscientiousness that can run invisibly in a gaming environment. The stealth assessment, and the process we are using to create it, are described next.

A Stealth Assessment of Conscientiousness

Stealth Assessment and Evidence-Centered Design

Stealth assessments are embedded in digital games such that they are unobtrusive to the learner being assessed (Shute, 2011; Shute & Ventura, 2013). These assessments use the learner's in-game actions to develop a belief about a student's level on a certain competency, and this belief about the student is updated over time to more accurately reflect her or his knowledge, skills, and attributes. Stealth assessment is based on the Evidence-Centered Design framework, or ECD (Mislevy, Steinberg, & Almond, 2003). This framework defines an approach for developing valid

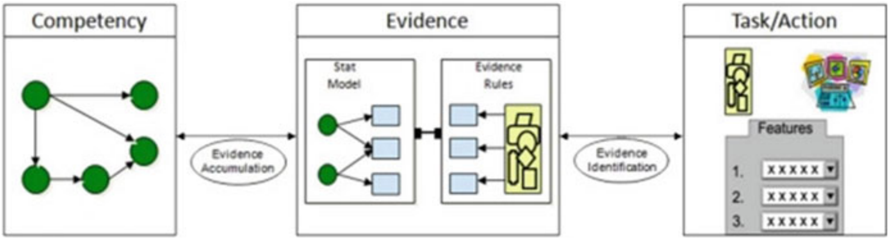

Fig. 21.1 A graphical representation of the ECD framework (From Mislevy et al., 2003)

assessments and is comprised of three models (Fig. 21.1). The competency model (CM) defines the competency or competencies of interest (e.g., algebra knowledge, problem solving skill, creativity, conscientiousness). The task model (TM) defines the features of the task environment that will elicit evidence of the competency or competencies of interest. The evidence model (EM) defines what constitutes evidence of the competency and acts as the statistical "glue" between the competency and task models. The evidence model is comprised of two parts. The evidence rules take the stream of data from the task environment (e.g., student actions) and convert it to observable variables. The statistical model specifies the relationships between these observable variables and the competency variable(s). This framework facilitates the development a valid evidence chain from the competency variables (CM) to observable variables (EM) to in-game actions (TM).

To implement the competency and evidence models for our stealth assessments, we use Bayesian networks (for more information on the mathematics of Bayesian networks and the range of applications in education, see Almond, Mislevy, Steinberg, Yan, & Williamson, 2015). These networks graphically represent the conditional dependencies among the competency variables and the observed variables. One of the benefits of Bayesian networks is that they allow us to accumulate evidence and update our beliefs over time. In our stealth assessments, as students play the game, they provide a stream of data that is analyzed in real-time. In turn, the system's beliefs about the competency variables are also updated in real-time. This accumulation allows us to obtain progressively more accurate measurements of competency variables as time goes on. Thus, stealth assessment allows for valid, real-time, unobtrusive assessments of students and avoids the weaknesses of self-report measures.

We use games as our assessment vehicles for a few reasons. First, games, and other computer-based learning environments, can automatically log student actions, which allows us to collect a lot of data at a fine-grained scale. This helps us to make valid inferences. Second, games are becoming important tools for learning and teaching. Research suggests that games, when properly applied, can improve learning outcomes (Wilson et al., 2009) and help develop twenty-first century skills, such as problem solving (Gee, 2007; Shute, Ventura, & Ke, 2015). Therefore, we believe that games can act as learning and assessment environments at the same time. Third, games are very popular and engaging, especially for young adults (Lenhart et al., 2008). People play games for their own sake and find their contexts meaningful, which improves the validity of the measurements. Additionally, the engagement that games offer makes the assessment unobtrusive, which can reduce test anxiety. However, while games are excellent assessment vehicles, care still needs to be taken to select or develop a game that meets the needs of each individual assessment. We describe the game we selected for our assessment of conscientiousness, as well as the reasons for that choice, next.

Physics Playground

We elected to implement a stealth assessment for conscientiousness in the game *Physics Playground* (formally called *Newton's Playground*; Shute & Ventura, 2013; Shute, Ventura, & Kim, 2013). *Physics Playground* (Fig. 21.2) is a two-dimensional puzzle game designed to help students in middle school and high school develop their conceptual understanding of physics. In the game, players attempt to move a green ball to a red balloon, primarily by creating and using various agents of force and motion (i.e., ramps, levers, pendulums, and springboards). To create the physics agents, player must draw them on the screen using the mouse. Once drawn, these objects come to life and behave in accordance with various physics principles, such as Newton's Three Laws.

Physics Playground features 74 levels spread across seven playgrounds with increasing difficulty. Success in each level is two-tiered and based on the number of objects players create to complete the level. Players who simply beat the level get a

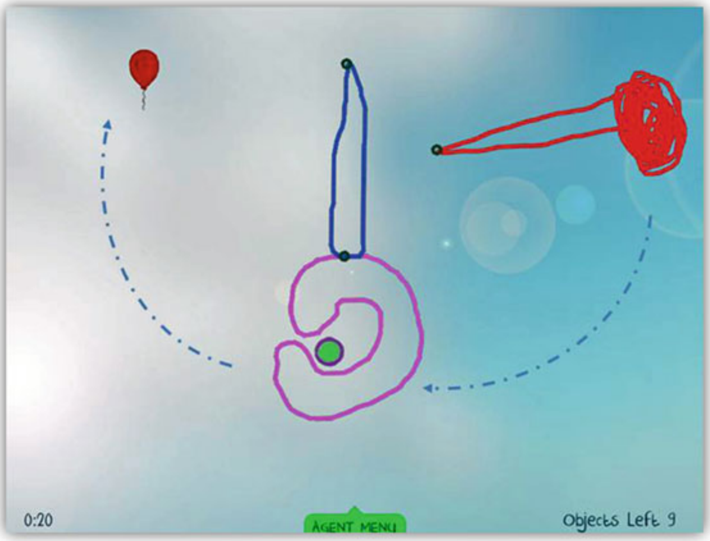

Fig. 21.2 An example of a level in *Physics Playground*. The player has drawn a pendulum object to hit a second pendulum and send the ball up to the balloon

silver trophy, while players who solve the level with fewer than the par number of objects get a gold trophy. Gold trophies indicate mastery of the agent(s) the player used in the level (e.g., mastery of pendulums, which in turn allows for inferences about mastery of relevant physics concepts). Silver trophies indicate that the player may not have mastery of the agent(s). Before starting the game, players view tutorial videos that teach them how to draw and use each of the agents of force and motion. These videos can be viewed again at any time.

There are two main reasons that we chose to use this game to develop our conscientiousness assessment. First, it was a game that we developed internally. Therefore, we could implement the stealth assessments and make changes to the game without restriction, which makes the process much easier. In particular, this allowed us to implement a log file system that facilitates data collection and organization. These log files record each action as well as a variety of information associated with each action, such as the time of the action, the number of restarts of the level, the number of objects used, and the coordinates and trajectory of the ball. These pieces of data are all used to update the assessment's beliefs about the player's conceptual physics understanding, as well as other competencies.

Second, players have the ability to exhibit most of the facets of conscientiousness in *Physics Playground*. Players can demonstrate tenacity on particularly challenging levels (persistence), make plans before redoing a failed level (organization), think carefully about each game action (carefulness), and go for gold trophies (perfectionism). This allows us to collect data from the game that accurately represents the student's level of conscientiousness. However, it is worth noting that the dependability facet does not lend itself well to a game-based stealth assessment of conscientiousness. Dependability refers to actions such as doing your work on time and keeping your promises. These are actions that either are not measurable automatically in a gaming environment or are confounded by other competencies. For example, completing work on time is confounded with ability in *Physics Playground*. This said, we believe that our stealth assessment can accurately measure conscientiousness with indicators of the four other facets. Our working competency model of conscientiousness is described next.

Competency Model of Conscientiousness

As discussed previously, dependability does not lend itself to a game-based assessment of conscientiousness. Thus, we did not include it in the competency model for our stealth assessment. We started by working with a four-factor model of conscientiousness: persistence, organization, carefulness, and perfectionism. However, the facets of conscientiousness are not directly observable. We therefore needed to develop a variety of in-game indicators for each of the facets. To determine these indicators, we went back to the literature on each of the facets. For example, in the persistence literature, persistence has often been measured by time spent on and attempts to solve very hard or impossible tasks (Eisenberger & Leonard, 1980; Feather, 1961). Thus, we developed the following indicators for persistence: *Time*

Spent on Unsolved Problems, *Number of Level Restarts*, and *Number of Level Revisits*. We also explored existing, validated measures of each of the facets, such as items in the International Personality Item Pool (Goldberg, 1999). While these previous measures were all self-reports, they gave us ideas about what types of indicators would measure the facet of interest and be appropriate for the game.

However, while defining the indicators, we discovered that the indicators of organization and the indicators of carefulness tended to be the same. For instance, the average number of objects drawn per level (reverse-coded) was an indicator of organization (i.e., organised players have a plan and don't need to draw many extra objects) and of carefulness (i.e., careful players think carefully about when and where to draw an object, and draw fewer objects as a result). Therefore, we decided to combine the organization and carefulness facets into a single facet, called *carefulness*, for the competency model of the conscientiousness stealth assessment. This three-factor competency model, with the complete list of indicators for all facets, can be seen in Table 21.1.

Next Steps

Our next steps in this project are to implement the conscientiousness assessment into Physics Playground, to validate the assessment, and to adjust the assessment as needed. Implementing the assessment will require us to build the Bayesian networks (with conditional probability tables) and embed them into the game. Then, we will need to conduct a pilot study to test the validity of our stealth assessment. To do this, we will have students play Physics Playground with the stealth assessment embedded and complete an external measure of conscientiousness. We can calculate the correlation between the stealth assessment and the external measure to

Table 21.1 The competency model of conscientiousness used for our stealth assessment where [R] refers to indicators that are reverse-coded

Competency	Facets	Indicators
Conscientiousness	Persistence	Time on unsolved problems
		Number of restarts on unsolved problems
		Number of revisits to unsolved problems
	Carefulness	Number of object limits reached in a problem [R]
		Average number of objects drawn per level [R]
		Average time, in seconds, spent drawing per object
		Average time, in seconds, between actions
		Average number of seconds before making an action on the first attempt
	Perfectionism	Ratio of gold trophy solutions to silver trophy solutions
		The number of revisits to levels with a silver trophy
		The number of restarts of a level in less than 3 actions

determine validity. However, measures of conscientiousness tend to be self-reports, so we will likely be comparing the stealth assessment to self-report measures. Due to the problems with self-report, mentioned earlier, we expect that there will be small to moderate relationships between the measures. This validity study will also allow us to determine whether our competency model or Bayesian networks need to be adjusted (e.g., altering the difficulty or discrimination parameters in the Bayes nets based on pilot data). After demonstrating the validity of the stealth assessment of conscientiousness, we will be able to measure conscientiousness accurately and, in turn, conduct meaningful research on it. Our ideas for future research on conscientiousness are described next.

Future Directions for Conscientiousness Research

There are three main directions in which research on conscientiousness needs to go. In this section, we discuss these different directions and how the implementation of a game-based stealth assessment can benefit them. We start by discussing how we might develop conscientiousness in students. We then describe how instruction might be designed to adapt to different levels of conscientiousness. Finally, we focus on the persistence facet of conscientiousness to explore whether or not it is a state or a trait and how that distinction impacts education practice.

Developing Conscientiousness

While personality traits, such as conscientiousness, are often considered to be relatively stable, previous research suggests that people can, in fact, learn to become more conscientious over time. The work of Eisenberger (1992) suggests that persistence, which he calls *industriousness*, is learned over time based on how a person is rewarded for their effort. That is, persistence may become generalised, as effort rewarded in one environment often impacts persistence in other environments. Thus, beneficial personality traits can be developed, and unhealthy aspects can potentially be attenuated.

Since conscientiousness predicts a variety of academic outcomes, helping students to develop conscientiousness should be a focus of future research. This research needs to examine the particular types of interventions and/or contexts that will help students to efficiently and effectively develop their conscientiousness. For example, perhaps requiring middle school students to use agendas will help them develop conscientiousness. Or perhaps certain teaching methods develop conscientiousness better than others. This type of research will likely need to be longitudinal, checking in on the sample of students periodically to measure conscientiousness over time. Our proposed stealth assessment of conscientiousness may be used to conduct these periodic assessments.

Adapting to Different Levels of Conscientiousness

Another branch of future conscientiousness research concerns the ability to adapt instruction based on the learner's estimated level of conscientiousness. This is particularly important if developing conscientiousness through direct instruction isn't possible or practical. Some prior research suggests that conscientiousness-based adaptation is useful. For example, Cheramie and Simmering (2010) found that people lacking in conscientiousness need more accountability in their learning. It therefore seems likely that people with high and low conscientiousness levels will thrive under different situations and with different forms of support. Future research should clarify what situations and types of support specifically help low conscientiousness students and what situations and types of support specifically help high conscientiousness students.

The stealth assessment proposed here can measure conscientiousness, which can in turn be used by educators to tailor instruction to individuals' needs. More interestingly, the conscientiousness stealth assessment can also be used to drive real-time adaptivity in a computer learning environment, such as a game. Since the stealth assessment runs in real-time, the learning environment can change on the fly based on the system's current beliefs about the student. For instance, if the stealth assessment determines that the student is too low in conscientiousness (based, perhaps, on some cut-score), the game might add in specific goals that the player needs to complete to increase accountability. The feedback and support can be applied as soon as possible. This contrasts with nonadaptive educational environments, where feedback and support only appear after the fact. For more on adaptivity in educational contexts, see Shute and Zapata-Rivera (2012).

Persistence: State or Trait?

It is often assumed that some people are more persistent than others, and that this is reflective of differences in personality. However, research suggests that external factors also matter when it comes to persistence. For example, both Feather (1961) and Eisenberger and Leonard (1980) found that a person's expectations of success influenced how long they would stick with a task. Thus, whether or not someone persists at a task is not just a function of their personality. It is also a function of the nature of the task. This makes intuitive sense, as people may persist longer on tasks they find worthwhile, interesting, and/or feasible.

However, this begs the question of whether or not we should conceptualise persistence as a state, a trait, or both. Future research should explore in what ways persistence is a state and in what ways it is a trait. In particular, this research may need to examine when it is useful to think about persistence as a state and when it is useful to think about it as a trait. In this regard, it might make sense to distinguish between persistent behavior (a state) and a persistent disposition (a personality trait). This conceptualization matters because it impacts how we approach helping students. If we think about persistence as a state, then we might focus on designing our educational environments to encourage persistence. On the other hand, if we think about persistence as a trait, then we might focus on training students to be conscientious. Of course, it is possible that we need to think of persistence in both ways. For instance, perhaps we should design environments that reward effort to encourage persistent behavior (state), which in turn can develop a persistent disposition (trait), as Eisenberger (1992) suggests. By validly measuring persistence with our conscientiousness stealth assessment, researchers can more fully explore the nature of persistence.

Stealth Assessment and Other Noncognitive Competencies

Throughout this chapter, we have discussed the importance of conscientiousness, how we are measuring it, and what still needs to be learned about it. However, we also wanted our work on conscientiousness to serve as an exemplar of how to develop a valid assessment of a noncognitive competency. We conclude this chapter with a discussion of the strengths and limitations of the stealth assessment of noncognitive competencies, as well as some specific suggestions for how to use stealth assessment, so that other researchers can effectively use it to meet their needs.

Strengths and Limitations of Stealth Assessment

The strengths of using stealth assessments to measure noncognitive competencies have been described throughout this chapter. For clarity, we briefly state them again here. First, stealth assessments are unobtrusive such that the learner does not know that they are being assessed. The distinction between learning and assessment is completely blurred. This reduces the saliency of the assessment, minimizing test anxiety and consequently improving validity. Second, stealth assessments are based on a student's actions, which counters the aforementioned issues inherent in self-reports (e.g., social desirability effects). Third, stealth assessments run continuously while students play the game. This facilitates the examination of noncognitive competencies over time and allows the system to adapt to the student on the fly. Fourth, stealth assessments are embedded in educationally relevant environments. Thus, noncognitive competencies can be assessed while students are learning. In summary, stealth assessments are efficient, valid, and do not disrupt learning.

However, it is also important to acknowledge the limitations of stealth assessment. For one, stealth assessment can be a difficult and time consuming process. It requires researchers to engage in a variety of processes, which include thoroughly reviewing the literature, developing competency, evidence, and task models, embedding the stealth assessment into a gaming environment, and refining the assessment through validity and other pilot studies. It is also requires a variety of skill sets, including those of educators, psychometricians, and computer scientists. Therefore, before deciding to use stealth assessment, researchers must ensure that they have the time, resources, and skills to successfully complete the process.

Moreover, stealth assessment may not be appropriate for measuring all noncognitive competencies. For example, while we consider dependability to be a facet of conscientiousness, we could not find a valid way to measure it in Physics Playground. Therefore, it ended up not being a factor in our implemented assessment. Thus, researchers looking to use stealth assessment need to carefully think about whether or not it is appropriate for the construct they are studying. If researchers decide that stealth assessment is appropriate, then they need to carefully select the right learning environment/game for the construct they are studying. There needs to be alignment between the environment and what is being measured. For example, while Physics Playground is a great environment for assessing physics knowledge, problem solving, and conscientiousness, it would not be suitable to measure noncognitive competencies such as leadership and communication, at least without modification.

Additionally, researchers need to choose a game that they can modify, whether it is a game made in house or obtained from a third party. The reason for this is that stealth assessment requires the researcher to embed data collection directly into the source code of the game. If this access cannot be achieved, stealth assessment cannot be used. We have achieved some success using our own game (Shute et al., 2013) and through partnerships with game developers (Shute et al., 2015) in past work, so this an obstacle that can be overcome with good planning and preparation.

We present these limitations here to give readers a better understanding of when stealth assessment might be appropriate, what types of collaborations are necessary, and problems they may encounter. Despite these limitations, we believe that stealth assessment is useful in a wide variety of situations. We next present some practical tips for those looking to use stealth assessments in their work.

Stealth Assessment Advice

First, researchers should take care when creating log files for a game or adapting log files from an existing game. The log files need to be simple and easy to parse. If they are not, creating an organised assessment can become very challenging. This a particular concern when adapting a third party's log files. Typically, these log files were never intended for assessment, so they will likely contain extraneous information and can be difficult for the researcher to understand. Researchers will need to work with the third party to adapt the logging system to their needs, or potentially create a new logging system.

Second, and as briefly discussed above, demonstrating validity is an important part of developing a stealth assessment. This can be challenging because external measures that address the same construct as the stealth assessment may or may not have good alignment. For example, conscientiousness is typically measured with self-report measures. However, the stealth assessment described in this chapter is expected to be an improvement over self-report measures. Thus, these measures have poor alignment and we do not expect (nor do we especially desire) that our stealth assessment measures will be highly correlated with the self-report measures. We expect small to moderate correlations at best. When possible, though, it is important to make sure that there is alignment the external measure and the stealth assessment. For example, in our previous work on persistence (Ventura & Shute, 2013), we used a performance-based measure of persistence—the amount of time spent on an impossible task—in addition to self-report measures to validate our persistence stealth assessment. This allowed us to be confident that our assessment was valid. For more detailed stealth assessment recommendations, see Wang, Shute, and Moore (2015).

Conclusion

In this chapter, we demonstrate the need to measure conscientiousness in educational settings and discussed the complexity inherent in this task. We hope that this shows (a) educators the importance of conscientiousness, and (b) researchers the need for more thorough research on conscientiousness. The stealth assessment presented here acts as a jumping off point for future research on conscientiousness. However, we also hope that this chapter encourages researchers to examine stealth assessment as a potential means of collecting valid information on a variety of noncognitive competencies and gives them ideas about how to get started. Stealth assessment allows for more valid data collection than the self-report measures used for many noncognitive competencies. With more valid data, we can develop a deeper understanding of the skills and traits that impact learning and, in turn, help students of all ages improve their learning outcomes.

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Chapter 22
Integrating Computer-Assisted Language Learning in Saudi Schools: A Change Model

Saleh Alresheed, Andrea Raiker, and Patrick Carmichael

Abstract Computer-assisted language learning (CALL) technology and pedagogy have gained recognition globally for their success in supporting second language acquisition (SLA). In Saudi Arabia, the government aims to provide most educational institutions with computers and networking for integrating CALL into classrooms. However, the recognition of CALL's efficacy does not translate into easy acceptance and integration in English as a Second Language or English as a Foreign Language (ESL/EFL) classrooms in Saudi schools, particularly where teaching of both English language and information and communication technologies (ICT) is subject to religious and cultural constraints. There are other barriers that impede native Arabic speakers from learning English. Accordingly, the research question addressed in this paper is an exploration of the overt and covert factors that affect CALL use and integration in Saudi Arabian secondary schools. A case study approach using mixed methods was employed to interview and observe a sample of teachers and school inspectors in urban and rural secondary schools. Results were supplemented with an online questionnaire and analysed using both descriptive statistics and thematic analysis.

The findings lead to recommending a model to address the covert and overt issues identified, and provide systematic support for integrating CALL into Saudi Arabian English language classrooms.

Keywords CALL • English language teaching • Saudi Arabia • Second language acquisition • Computer-assisted language learning (CALL) • Saudi schools • Government • Computers • Networking • Classrooms • Digital technologies • Language learning classrooms • English language • Information and communication technologies (ICT) • Culture • Mixed methods • Interview • Observe • Teachers • School inspectors • Secondary schools

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Introduction

The Saudi Ministry of Higher Education (2011) in Saudi Arabia is aware of the need for its citizens to be at an educational and linguistic par with peers in leading nations in order to actively participate in international dialogue, employment and trade. The government has announced various initiatives to address the problems of uneven education and prepare its citizenry for employment opportunities in international corporations (Oxford Business Group, 2010). However, the most pressing issue is to improve the ability of Saudi students to communicate in other languages. No exchange of dialogue, trade or employment can be successful unless Saudis can communicate with others around the world and, to do so, they need a high degree of proficiency in English.

Khan (2011) and Oyaid (2009) argue that Information Communication Technology (ICT) is an essential element of education, especially in the field of language learning and teaching. Computer-assisted language learning (CALL) technology and pedagogy have gained recognition internationally for their success in supporting second language acquisition (SLA) (Lambropoulos, Christopoulou, & Vlachos, 2006). According to Mahdi (2013), the Saudi government is committed to providing most educational institutions with computers and networking for CALL.

There has been considerable research into barriers to the use of technology and current technology acceptance models (Anderson, Groulx, & Maninger, 2012). Several models such as the technological pedagogical content knowledge (TPACK) model and the technology acceptance model (TAM) have been created to improve and understand the use of technology (Alsofyani, Aris, Eynon, & Abdul Majid, 2012). The research leading to the development of the TPACK and TAM models provides a foundation for analysing technology acceptance in English language classrooms.

Integrating CALL into schools requires planning and effort, particularly given the cultural and attitudinal barriers to its adoption (Al-Kahtani & Al-Haider, 2010). This research investigated the barriers to incorporating CALL in EFL classrooms and the expectations surrounding the use of such technologies. The aim was to create a model for integrating CALL more comprehensively based on identifying the needs of the Saudi educational context. Exploring the main factors affecting CALL use was the initial step to understanding the extent of CALL's integration, and thus a basis for developing a model for supporting the Ministry of Education's implementation of this pedagogy.

Literature Review

Integrating Computer-Assisted Language Learning (CALL)

The continuous and rapid developments in ICT and education, along with changes in the pedagogy of SLA, have led to many changes in CALL, its implementation and integration. Several typologies of CALL development have been undertaken

(Bax, 2003; Warschauer, 1996; Warschauer & Meskill, 2000) with the latest version by Bax (2003) identifying the eventual objective of CALL as "normalisation".

Discussing the future of CALL, Bax (2003) suggests the concept of "normalisation" as a central aim for CALL practitioners to strive for. He notes that the state of normalisation will have been achieved when computers are an integral part of every lesson and other aspects of classroom life,

> like a pen or a book without fear or inhibition, and equally without an exaggerated respect for what they can do. (p. 23)

He goes on to say that he believes that the new agenda for the future should involve planning for normalisation and then moving towards it by taking the following steps:

(a) Identifying the critical factors which normalisation requires;
(b) Auditing the practice of each teaching context in the light of these criteria;
(c) Adjusting our current practice in each aspect to encourage normalisation.

To achieve normalisation in any educational context, numerous factors need to be considered. These differ from context to context, of course, but might include improvements in the size, design and location of the technology, as well as reorganisation of other physical aspects of the educational setting, timetabling and so on.

Lankshear and Knobel (2007) note that young learners in the developed nations have a new attitude to life that is fundamentally different from conventional attitudes, and is enhanced by a sense of reality that extends to virtual space. Blogging, online chatting, online gaming, iPods, smartphones and instant messaging are all normal activities. According to Warschauer and Meskill (2000), these digital tools promote the socio-cognitive pedagogy for CALL by emphasising the value of communicative and interactive instruction in authentic contexts.

Numerous studies have shown that the mere availability of technology does not guarantee its effective use and integration in education. Yet the material availability of the technology and access to it are prerequisites for its incorporation into classroom activities.

Teachers' attitudes towards technology and their skills in using it are also crucial in determining instructional choices for normalising CALL (Elsaadani, 2013; Kreijns, Van Acker, Vermeulen, & Van Buuren, 2013). Positive attitudes do not always mean high ability. Although limited access to Internet-connected computers, the teachers showed highly positive attitudes toward the use of computers. It indicates that teacher comport, confidence and competency should be genuinely considered in CALL teacher training programmes (Son, Robb, & Charismiadji, 2011).

Zaid (2011) and Oyaid (2009) stated that provision of resources, motivation and training issues are among the key challenges still faced by introducing CALL in Saudi Arabia. Covert barriers to use include negative attitudes toward the Internet and CALL. According to Sardegna and Yu (2015), the top three factors affecting participants' computer use were limited facilities, time and computer knowledge.

Moreover, Al-Amr (1998), and Saqlain, Al-Qarni and Ghadi (2013) mentioned that the easy availability of images of women, and discussion of taboo subjects

Table 22.1 Barriers to CALL

Barrier	International context	Saudi context (Al-Kahtani, 2007)
Material/overt	1. Insufficient number of computers or copies of software	1. Accessibility, i.e. difficulties in accessing the Internet, computers, technical support.
		2. Training—this is a major issue as both teachers and students require specific skills.
Non-material/covert	1. Teachers' insufficient ICT knowledge and skills,	1. Negative attitudes of teachers toward the Internet and CALL.
	2. The difficulty of integrating ICT in instruction,	
	3. Insufficient teacher time	

(such as dating and sexuality) have led some Saudis to believe that the Internet promotes anti-religious and anti-cultural morality.

Pelgrum (2001) and Al-Kahtani (2007) have classified barriers to CALL as material/overt and non-material/covert. These barriers are somewhat different in the international and Saudi contexts, as illustrated in Table 22.1.

The Restricted Saudi Educational Setting

Educational policies in Saudi Arabia are under direct government regulation (Oyaid, 2009). National curriculum, syllabi and textbooks are identical across the country. The management of education is controlled through two main organisations, namely, the Saudi Ministry of Education (MOE) and the Ministry of Higher Education (SMHE). The MOE is responsible for the country's educational policy. Education is mandatory for all children from 6 to 15 years and most study in government schools (Oyaid, 2009). The MOE introduced a 10-year plan in 2004 to reorganise its schooling system, introducing state projects for ICT in schools, along with teacher training and improvement to achieve the essential skills (Saudi Ministry of Education (MOE), 2004).

The new curricula aim is to assimilate ICT in education and cultivate students' "skills and encourage creativity and analytical thinking to fulfil the needs of all students" (Tatweer, 2008). Integrating ICT and education is the new official mantra in developing a modern educational system that will enable Saudi Arabia to be on an educational par with other technologically advanced nations. Oyaid (2009) argues that the uncertainty and ambiguity of high-level ICT policies hampers CALL integration.

CALL in Saudi Arabia and the Arab World

ICT was introduced in the Saudi education system in the 1990s, and has expanded in the last 20 years. Initially, it was used merely as an administrative tool but by the mid-1990s, computer studies were introduced as part of the secondary school curriculum (Alshumaim & Alhassan, 2010).

Studies in Saudi Arabia and the Arab world more generally have found that there was a marked improvement in writing skills when the learners used computers versus traditional methods (Alsouki, 2001). Al-Qomoul (2005) found that using an instructional software programme for English language learning greatly enhanced students' performance in comparison to traditional methods. Likewise, Al-Abdel (2009) substantiated the efficacy of CALL in improving Jordanian secondary learners' reading comprehension abilities. Bataineh and Bani Hani (2011) piloted a study examining the probable effect of a CALL programme on Jordanian sixth-grade learners' success in English. The results showed that language acquisition is greatly affected by the means of instruction, as there is noticeable variation between the successes of traditional and CALL instruction, in favour of CALL. According to Hani (2014), the most barriers in using CALL in Jordanian schools are inadequate number of computers, technical problems, teacher training, lack of time and high cost.

Methodology

A mixed methods approach to research comprises a combination of the two basic research methods: qualitative and quantitative. According to Leech and Onwuegbuzie (2009) mixed methods research combines the effectiveness of both quantitative and qualitative methods to substantiate strong research findings. Johnson and Onwuegbuzie (2004) define this type of research as "… the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (pp. 17–18). Mertens (2012) argues that the use of triangulation in mixed methods allows the researcher to better understand various data, and interpret findings with greater precision. Thus, this research will use a mixed methods combining both qualitative (interviews and observations) and quantitative (online questionnaire).

A pilot study with a small sample size (24) of Saudi teachers and MOE inspectors in region Q was undertaken to explore the extent to which CALL has been adopted, and to identify barriers to its integration into secondary school language classes.

Quantitative and qualitative data were collected through an online questionnaire and semi-structured interviews with 22 English teachers and two MOE school inspectors. Interview findings were triangulated with the questionnaire results and classroom observations in both rural and urban secondary schools. Semi-structured interviews included questions around themes such as comfort in using new technology, availability and access to CALL, the effects of the Internet and personal attitudes toward CALL use.

Survey data were collected electronically through the "SurveyMonkey" platform and transferred to SPSS version 21 where descriptive statistical analyses were performed. Free text questions were analysed using thematic analysis (recognition of patterns and recurrent themes), a framework outlined by Braun and Clarke (2006). The findings were then tested against existing models for CALL integration and technology acceptance and collated to form an emerging model for CALL integration in Saudi Arabia.

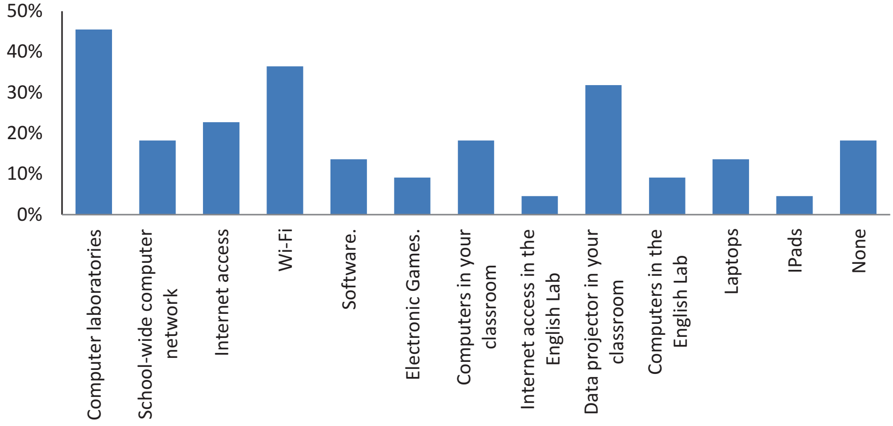

Fig. 22.1 Information on ICT equipment available at the schools

Findings

Demographic Data

The majority of EFL teachers were male and ranged from 25 to 40 years. At least 70 % of the respondents were older than 30. Most teachers had at least 6 years of teaching experience and just over 76 % were employed in city schools; 82 % held a bachelor's degree. Despite some respondents holding a master's degree, there was no significant correlation between education and age.

Computer Access in Schools

Over 80 % of respondents reported having no Internet access in their classroom, while slightly under half (45.5 %) reported that students had access to a computer laboratory. Just over a third reported that students had access to Wi-Fi technology at the school and just under a third had a data projector in their classroom. The range and extent of technology available is indicated in Fig. 22.1.

Over 70 % of respondents reported that they used the computer to prepare material in their classroom. Close to a third (31.8 %) reported using the Internet to communicate with their students. The availability of computer facilities for students after class time was low with less than 30 % of respondents reporting accessibility. In addition, just over 20 % of respondents expected students to use any available computer facilities. Finally, a number of other factors were reported as limiting the use of CALL including lack of computers, lack of training and lack of technical support. Cross-tabulation of data revealed that city schools had greater access to ICT than rural schools, a trend which was true for all ICT amenities. Location of the school greatly influenced ICT access.

Table 22.2 English teachers' self-reported ratings on MOE support

Statement	Not at all (%)	Slight (%)	Moderate (%)	High (%)	Total (*n*)
Technical support	50.0	27.8	16.7	5.6	18
Financial support 1: grant projects	66.7	16.7	5.6	11.1	18
Training support	56.3	31.3	12.4	0.0	16
Leadership	44.4	38.9	11.1	5.6	18
Financial support: support, awards for and award to innovative teachers	66.7	16.7	5.6	11.1	18
Planning	58.8	11.8	11.8	17.6	17

ICT Training

Slightly over 36.4 % of respondents had undertaken any form of ICT training. Of this group, slightly over a quarter completed training prior to their service as an English teacher (27.8 %), another quarter had completed in-service training (27.8 %), and the remaining proportion had had both pre-service and in-service training (44.4 %). Notably, close to half of respondents (45.5 %), who had undertaken ICT training, did so at a private training centre but less than half (45 %) had completed any training within the last 3 years. Of those without any ICT training (63.6 %), nearly three quarters cited "lack of MOE encouragement" for not doing so. Cross-tabulation of data showed that most of the trained teachers were under 30 years of age. Again, location had an impact on training, with more city teachers having training than their rural colleagues.

Computer Skills

Teachers' computer skills were very disappointing, with half to two thirds being unfamiliar with basic ICT skills. Making educational CDs, using emails for communication, distributions, chatting and so on were all activities out of reach for most EFL teachers, and especially those in the rural schools.

Ministry Support

Respondents were asked to rate the amount of support provided by their school/the Ministry to help them use CALL in their teaching. Table 22.2 provides a summary of the results.

Teachers' Attitudes

Teachers' attitudes toward CALL were ambivalent, with most recognising the efficacy of it as a training tool but still fearing its impact on Saudi culture and their future as EFL teachers. Location did have some impact on the attitudes of teachers; rural teachers were more worried about cultural damage and being replaced by computers (Table 22.3).

Table 22.3 English teachers' attitudes about using ICT in teaching and learning the English language

Statement	Strongly agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)	Total (*n*)
CALL is not better than any other traditional teaching.	23.5	0	41.2	11.8	23.5	17
CALL could help enhance the quality of language teaching and learning.	41.2	23.5	17.6	5.9	11.8	17
CALL will enable language teachers to address their students' individual needs in a better way.	23.5	23.5	23.5	17.6	11.8	17
Computers and IT-related technologies will replace language teachers in the future.	31.3	31.3	18.8	18.8	0	16
Computers will allow students to access possible culturally incorrect contents on the Internet.	29.4	47.1	5.9	5.9	11.8	17

Qualitative Findings

Classroom Observation

Two EFL classrooms were observed to gain an insight into the actual classroom practices adopted by teachers. Both classes were observed four times over a 4-week period; both were in city schools and had 22–25 students. Only one class (at school A) had a data projector and computer for the teacher's use only in the classrooms, while the only computers in school B were in the computer lab, and were only used by the computer science teachers. Both teachers used only PowerPoint slides for EFL teaching; one already had a data projector and the other used his personal laptop and projector. The class in school A used PowerPoint frequently, two to three times a week—whereas the teacher in school B used PowerPoint only two to three times in a term. The teachers primarily used grammar translation methods for teaching. There was no use of technology by students inside the classrooms in either school. Moreover, there was no motivation by the schools' principals to encourage teachers to use the technology.

Teacher Interviews

Analysis of the two English teacher interviews revealed some preliminary themes. Teachers claimed that when they used slides or short movies, the students were more interested and learned more easily. However, these were the only ICT activities used in class. There was no other CALL use in teaching. They mentioned that there were no suitable CALL English programmes/software for students.

Both teachers noted that most of their students had smartphones or tablets yet neither used ICT to contact their students outside school, nor did they assign any CALL exercises for lack of suitable programmes.

Interviews with Inspectors

Two inspectors from the MOE were interviewed about their opinions on CALL integration in secondary schools. Both inspectors were dissatisfied with the state of CALL. Both agreed that the main fault lay with the MOE itself for being unable to provide the necessary hardware and training.

Although the inspectors agreed that CALL was an extremely efficient teaching tool, they accepted that the MOE did not specifically provide ICT to EFL classrooms and were more interested in the integration of ICT within education more broadly. The inspectors asserted that most teachers preferred traditional teaching methods and, although a few teachers did recognise the importance of CALL, they were hampered by lack of hardware and software.

Requirements cited for CALL integration by the inspectors included a clear plan to integrate CALL, computers and new ICT equipment, teacher training, technical support and a new measurement form to encourage teachers to use CALL. These elements comprise part of the emerging model for CALL integration in Saudi Arabia proposed below.

It is clear that the MOE has not yet established any parameters for CALL in English departments. And because basic performance measurements neglect CALL, there is no motivation for teachers to integrate it. This leaves supervisors with no tools to enforce CALL adoption in classrooms.

Discussion and Conclusion

Findings from the pilot study have established many factors that are hampering the integration of CALL in Saudi secondary schools. Some factors are covert, such as the negative attitudes held by some teachers and lack of motivation at the MOE. Despite some fears regarding wrongful usage, many teachers use personal laptops to access multimedia. As most teachers noted that almost all students had smartphones or tablets, a lack of technological engagement in general cannot be the reason for the lack of engagement with CALL. There is also a definite lack of high-level incentives for the MOE and, to some degree, the school administration to integrate CALL more effectively.

Further covert issues elucidated by Al-Rojaie (2011) include lack of pedagogical knowledge and sufficient training in both teaching English and ICT. Furthermore, we find that CALL in EFL classrooms is not encouraged by the MOE insofar as teachers have to follow a strict format that does not include CALL but focuses on passing examinations. As one teacher noted, there are no digital or e-books to

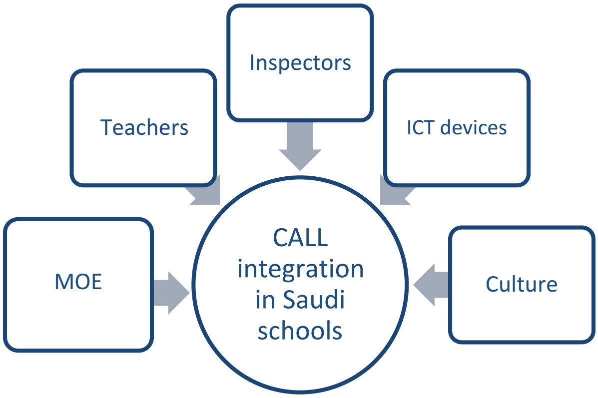

Fig. 22.2 Integrating CALL in Saudi schools: An emergent model

follow and there is no school website where students can log on and learn/communicate. These two constraints, in addition to the overt factors, have led to the negligible adoption of CALL.

This study also found that the overt factors, e.g. lack of computers and software detailed by Al-Kahtani (2007) and Pelgrum (2001), are among the reasons for failure to integrate CALL. Despite teachers and students having personal access to ICT—smartphones, tablets and laptops, they are unable to integrate CALL because of both overt and covert constraints. Far from providing ICT to all schools, the MOE is unable to maintain computers in the schools that do have such facilities. Furthermore, there is no effort being made to provide suitable software to teachers or enable them to search for or create their own programmes through training and removal of contextual constraints. These constraints are not linked to lack of funding or interest at the top level; it was established earlier that the SMHE (2011) is making a concentrated effort to improve EFL in Saudi Arabia. As such, the study has found the need to further investigate the discrepancy between the proposed ideals of encouraging EFL/CALL and its implementation. It is proposed that a model for CALL implementation should be developed which will ease CALL integration at the ministerial, administrative and school levels, bringing it eventually to the students' home as well as classroom (Fig. 22.2).

Implementation of the proposed model will require several steps. The first is to provide specific plans and identify the organisational processes necessary to providing computers and software to schools. Second, Saudi Arabian educational policy makers need to be made aware of the importance of co-ordinating training efforts to make them more accessible to teachers and allay their fears of being replaced by CALL. Third, teachers' pedagogical role in CALL environments needs to be refocused away from being "dispensers of knowledge" to being knowledge facilitators. Not only computer education but also pedagogical training is necessary to instill confidence in EFL teachers and motivate them toward incorporating CALL into their pedagogy. Culture is also one of the factors that should be addressed before integrating CALL.

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Chapter 23
Training Pre-Service Teachers in the Use of Challenge-Based Learning and Sandbox Experiences as Practical Applications of Digital Technology for Authentic Learning in the Twenty-First Century Classroom

Gregory Powell

Abstract This chapter provides insights into Challenge-Based Learning and Sandbox Experiences that integrate digital technologies for pre service teachers at a higher education institution in Victoria, Australia. A range of digital technologies are described that aim to build knowledge, promote active and engaged learning, independence, and tailor the learning to individuals for the twenty-first century. Through Challenge-Based Learning and the provision of Sandbox experiences pre-service teachers experience authentic learning inquiries that are critical to modern teaching and learning. They play, create, build, collaborate and reflect on their learning and demonstrate their understanding through the use of digital technologies.

Keywords Information and Communication Technologies (ICT) • Adoption • Integration • Evaluation • Teachers • Higher education • Pre-service teachers (students training to be teachers) • Sandbox experiences • Mathematics • Challenge based learning (CBL) • Design briefs • Challenge-based learning • Sandbox • Digital technologies • Pre-service teachers • Digital technologies • Teacher knowledge • Active learning • Autonomy • Personalised learning • Authentic learning • Teaching and learning • Teacher education experiences

Twenty-First Century Education

Education in the twenty-first century is about working with people and by people, supporting the development of personalised learning through innovations associated with inventing new teaching practices using up-to-date technologies in creative ways.

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There are co-construction pathways between learners and educators developing ambitious and radical innovative environments. The nature of learning today is "interactive and enabled by the very nature of the internet" (Ramsay & Terras, 2015, p. 383). De Freitas and Conole (2010) suggest five broad technological trends that have significant impacts on education into the future with:

- shifts towards ubiquitous and networked technologies
- emergence of context and location aware devices
- rich and diverse forms of digital stimulatory environments
- more mobile and adaptive devices
- technological infrastructure that is global, distributed and interoperable

The emphasis needs to be upon the transferable skills as the learners are demanding improved access and outcomes and the world economies are demanding new twenty-first century skills. Higher Education Institutes and schools need to take the initiative in designing active learning emphasising interaction rather than content (Anderson, 2004). Learning should be organised around modes of student engagement: learner–content interaction, learner–teacher interaction and learner–learner interaction (Anderson, 2004; Sims, 1999).

The changing digital landscape needs to build on the increasing and wide ranging experiences in the use of digital technologies where higher educational institutions and schools focus upon and provide students with technology integration skills. And as Banas and York (2014) state, "should focus not only on developing preservice teachers' technology integration skills, but also provide them with the skills to navigate new technologies" (p. 741).

These fundamental innovative changes occurring in the learning experiences offered by educational settings can be seen in how the modern student interacts, receives and responds to learning experiences in new and dynamic ways with an increased emphasis on transferable skills, situated learning (Lave & Wenger, 1991), communities of practice (Wenger & Snyder, 2000), critical thinking and critical reflection. As Nykvist (2008) states, "Students who use them will soon be the majority of students in the classroom" (pp. 167–168). The goal for all of us involved in education is to build future practice better than we have used in the past.

A rethinking of educational approaches more broadly and the effective and relevant use of Information and Communication Technologies (ICT) is required across all educational settings (Cuban, 1993). As Hedberg, Oliver, Harper, Wills, and Agostinho (2002) contend new technologies provide rich experiences and can be effectively applied in teaching and learning for the twenty-first century. Understanding the nature of technology tools in use today and the possibilities they afford users becomes paramount to the twenty-first century communities (Nykvist, 2008; Yang, 2006).

Changing Nature of Learning and Twenty-First Century Skills

Together with the changing nature of learning, the twenty-first century skills of creativity and innovation, critical thinking, problem solving, decision making, learning to learn, that are purposeful and experimental encompass new ways of thinking and working using digital technologies. And the work skills of communication, collaboration, competition, critical reflection, mentoring and peer reviewing are essential for the modern working environment (Bauman, 2001; Beck & Beck-Gernsheim, 2002; Beck & Lau, 2005; Sahama, Peach, Hargreaves, & Willett, 2010). Davies, Fidler, and Gorbis (2011) identified ten skills critical for success in the workforce: making sense, social intelligence, novel and adaptive thinking, cross cultural competency, computational thinking, new media literacy, transdisciplinarity, design mindset, cognitive load management and virtual collaboration (pp. 8–12). The authors argue that educational institutions "are largely the products of technology infrastructure and social circumstances of the past" and that there is an urgent need for these institutions to adapt and respond quickly to the rapidly changing landscape (Davies et al., 2011, p. 13). These characteristics provide strong and relevant connections that prepare learners for a world in which collaboration and change are ever present (Alexander, 2006; Bennett & Maton, 2010; Harris, 2006; Maloney, 2007; Warlick, 2006).

The Nature of Digital Technologies

Technology is an ever present reality in the lives of twenty-first century students and to be relevant such tools need to be digital. "Outside of the formal educational setting, students have access to high quality games, which incorporate high levels of interactivity and a multitude of pathways and levels of difficulty" (Gregory et al., 2014, p. 286).

Digital technologies describe a variety of applications and websites that provide users with the ability to create, share, collaborate and communicate information in an online environment "with greater ease than was previously available" Nykvist (2008, p. 167). Users are afforded with ICT capacity for inquiry, creativity, research, communication, competition and collaboration to construct new learning and insights that are accurate, authentic and relevant to the twenty-first century learners. Solutions to issues or problems identified are researched, evaluated, redesigned, reflected upon, linked to curricula and targeted at both local and global audiences. Educational content can be delivered via such technologies that provide for multimedia and multimodality to suit a range of learning styles, differing abilities and even alternative formats for students with disabilities. The social interactions among learners play a crucial role in the processes of learning and cognition (Vygotsky, 1978). It is the participatory nature that many digital technologies afford that cognitive tools such as Web 2.0 technologies provide a vision of what future learning environments should be like (Kim & Reeves, 2007). When linked to social constructivist learning approaches (i.e. authentic pedagogy) and real world issues, learners (i.e. pre-service teachers and school students) are being prepared for the "messiness" of the twenty-first century workplace (Lombardi, 2007, p. 3).

Interactivity is one of the major features of digital technologies and has enormous potential for the improvement of teaching and learning in all educational settings as users interact with software applications. The appeal for educators is the inherent affordances digital technologies provide for a variety of student learning styles and teaching strategies. Users become active participants through exploration of the software application as well as engaged as authors in creating digital media that builds ICT skills, encourages participation and collaboration in the learning process, is authentic and provides for creativity and innovation.

As students become more actively involved in their own learning the educator's role moves to one of facilitator in which knowledge construction opportunities are provided to students through the use of digital technologies. The role of the student in the learning process moves from passive to active participation and engagement as they begin to take ownership of their own learning (Collins & Halverson, 2009; Gaffer, Singh, & Thomas, 2011; Levin & Alexander, 2008).

Researchers into ICT use in education, such as Turkle (1984), Papert (1980) and Yelland, Neal and Dakich (2008), as well as Dede (2009, 2013) argue that students construct reality from their own lived experiences and prior knowledge. The digital technologies utilised by students today provide an authentic context for learning through investigating, communicating and creating with ICT (http://www.education.vic.gov.au/school/teachers/support/Pages/planning.aspx).

The use of digital technologies provide opportunities for pre-service teachers and school students to create, play, design, trial, reflect and explore educational ideas associated with curriculum content. The use of ePortfolios, WebBlogs and Wikis, for example, affords opportunities for collaboration, reflection, innovation, creativity and design in an online format. Knowledge is built, learning is active, and assessments (using Rubrics) are easily built into tasks promoting authenticity. Engagement, motivation and challenge are provided through the use of such technologies.

Challenge Based Learning and Digital Technologies

For pre-service teachers and school students the author encourages a multidisciplinary approach across a range of technologies used in their daily lives to solve real world issues. Collectively this is known as Challenge Based Learning (CBL).

> Challenge based learning is a collaborative learning experience in which teachers and students work together to learn about compelling issues, propose solutions to real problems, and take action. The approach asks students to reflect on their learning and the impact of their actions, and publish their solutions to a worldwide audience (Johnson & Adams, 2011, p. 4).

The framework for Challenge Based Learning (CBL) begins with a Big Idea (or Issue), followed by an essential question, a challenge, guiding questions, activities, resources, providing solutions through action based on reflection, assessment and finally publishing to a wider audience (ACOT, 2009) (Fig. 23.1).

Digital technologies provide an extensive range of applications to assist such inquiry with the CBL framework requiring pre-service teachers working collaboratively in small groups, having 24/7 access to technology and mentoring from lecturers. Assessment Rubrics are established to support the investigation and formal assessments can be incorporated into the process. Ongoing research and individual and team reflection into the Big Idea (or Issue) are essential. With the proliferation of

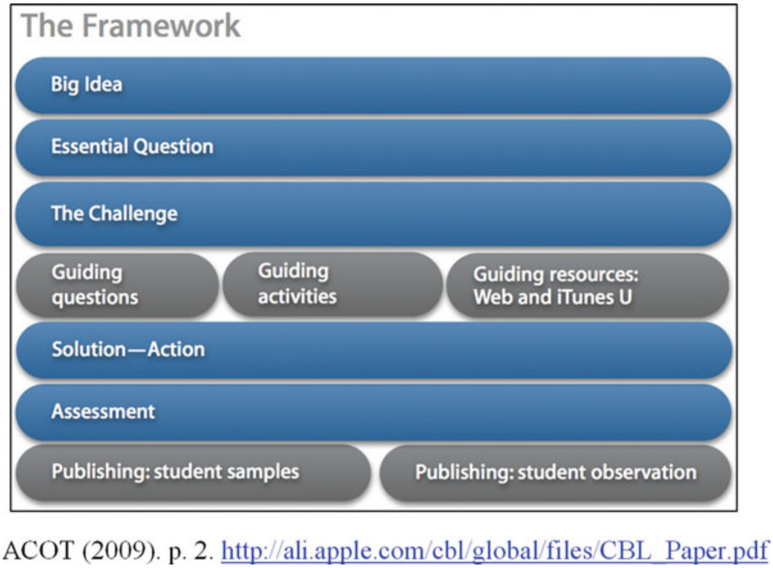

Fig. 23.1 Framework for challenge based learning. ACOT (2009), p. 2. http://ali.apple.com/cbl/global/files/CBL_Paper.pdf

digital technologies pre-service teachers and school students are provided with multiple means of representation and publishing to a worldwide audience (ACOT, 2011). For us here at a higher education institution when adopting the CBL framework across a range of subjects the issue selected and the inquiry process researched by pre-service teachers working in teams is linked to the Australian Curriculum and specifically for Victorian schools, known as AusVELS.

> AusVELS is the Foundation to Year 10 curriculum that provides a single, coherent and comprehensive set of prescribed content and common achievement standards, which schools use to plan student learning programs, assess student progress and report to parents (VCAA, 2014).

Until recently at La Trobe University (School of Education) such CBL inquiry was referred to as a Webquest. An online example of such a Webquest as an integrated unit of study by Allinson and Egan (n.d.) based on Refugees can be found online at: http://webquests.wix.com/refugeeswebques#! Over the last 2 years the decision was made to change this to iQuest (rather than Webquest) as it resonated better with newer technologies available and reminded the pre-service teachers that the process was one of inquiry.

Pre-Service teachers design their interdisciplinary iQuests in collaborative groups and scaffold the learning through following the building blocks. These steps are: The **Introduction**: that orients students and captures their interest (ESSENTIAL QUESTION). The **Tasks**: describe the activities and end products that students will participate in. The **Process**: explains strategies students use to complete the tasks. The **Resources**: are the web sites and other resources students used to complete the task. The **Evaluation**: measures the results of the activities. The **Conclusion**: sums up the activities and encourages students to reflect on the processes and results. **Teachers**' **Page and Credits**: are for other teachers to read. Although students are a liberty to utilise their own building blocks to produce their iQuest. The iQuests become a valuable educational resource that the pre-service teachers can use when in schools on Professional Experience. An example of an iQuest titled: Does Clean Equal Safe? can be found online at: http://isitmeantoclean.weebly.com/index.html (Ali, Kose, & Brouvalis, 2015).

To support such inquiry pre-service teachers are exposed to an extensive range of technologies from software packages such as MS Word™, MS Publisher™, MS PowerPoint™, MS Excel™, Inspiration™, Adobe Photoshop™, Windows Movie Maker™, Blackboard (Moodle)™, PebblePad™ to the use of Web 2.0 technologies and innovative websites such as Blogs, Wikis, Weblogs, Voice Threads™, Wix™, GoAnimate™, Wordle™ & Tagxedo™, Make Believe DeVolver™ Movie Maker, Prezi™, Vimeo™, Storybird™, Voki™, Zooburst™, BuildYourWildSelf™, Scootle, ABC Splash™ and FUSE™.

Most assessment tasks within educational subjects at La Trobe University (School of Education) require reflection, research, inquiry, communication, collaboration and creation. PebblePad™ is used extensively as an eResource providing a creative ePortfolio portal for pre-service teachers in Science, Mathematics, English, Professional Practice, Research, Multimedia and ICT. Allied to this is the university's use of Moodle™ as a Learning Management System. Both systems provide users with a plethora of resources including hyperlinks to online and blended learning modules and have provision for uploading of assignments for sharing among the student population. The CBL inquiries developed by pre-service teachers are ably supported through the use of these forms of Learning Management Systems.

Pre service Teachers Use of Digital Technologies at La Trobe University

Across a range of subjects in both undergraduate and post graduate degrees La Trobe University pre-service teachers within the School of Education are exposed to a range of Web 2.0 technologies and provision for assessments using such technologies is inbuilt into subject learning guides. Rubrics are developed to provide assistance to the pre-service teachers as they reflect, build, develop and experiment with digital technologies they have selected (Carlson & Jesseman, 2011). The introduction to a range of digital technologies has provided new ways of presenting information and ideas in interactive ways unfathomable 20 years ago where essays and written examinations were the main forms of assessment.

Today the pre-service teachers can upload digital content created within collaborative small teams as well as individually to such websites as: Flickr™, Vimeo™, PebblePad™, Moodle™, Presi™, Go Animate™, as well as a range of WIKIs, and Blogs. Students can upload the content from lecture theatres, tutorial rooms,

Fig. 23.2 Example of Materials Technology used to solve a problem

computer laboratories, their own homes, libraries as well as any establishment offering free Wi-Fi. The sharing of such digital content can be limited to members of specific online groups, or delivered to a global audience utilising such sites as Google Blogspot™, Vimeo™ and Flickr™.

Examples include: a Science experiment videoed as part of a science and technology subject and uploaded to Vimeo: https://vimeo.com/40807341 as well as a Design Brief application (see below) involving materials technologies; developed by pre-service teacher Brendan Wardlaw (2013a, 2013b). Pre-service teachers were presented with a Design Brief and all physical materials they required to solve the problem of "How to Make a Frog Jump" (Fig. 23.2). They were given a small piece of cardboard, a rubber band, a coloured picture of a frog, and a small piece of sticky-tape for the task.

As they worked in pairs through the Design Brief three-step process (Investigate/Design, Produce, Analyse/Evaluate=ID/P/AE) pre-service teachers created solutions to the problem posed (Fig. 23.3). Each pair reported back to the whole workshop cohort and demonstrated their designs.

Videos were made of the jumping frog and then uploaded to Vimeo™ by each student pair. This video clip developed by pre-service teacher Brendan Wardlaw (2013a, 2013b) can be found online: https://vimeo.com/40493898. This process allowed pre-service teachers to demonstrate their technological understandings and ICT skills through digital applications that can be replicated in any classroom.

Other examples of digital technologies used for inquiry and reflection at La Trobe University (School of Education) by two pre-service teachers Kym Barbary

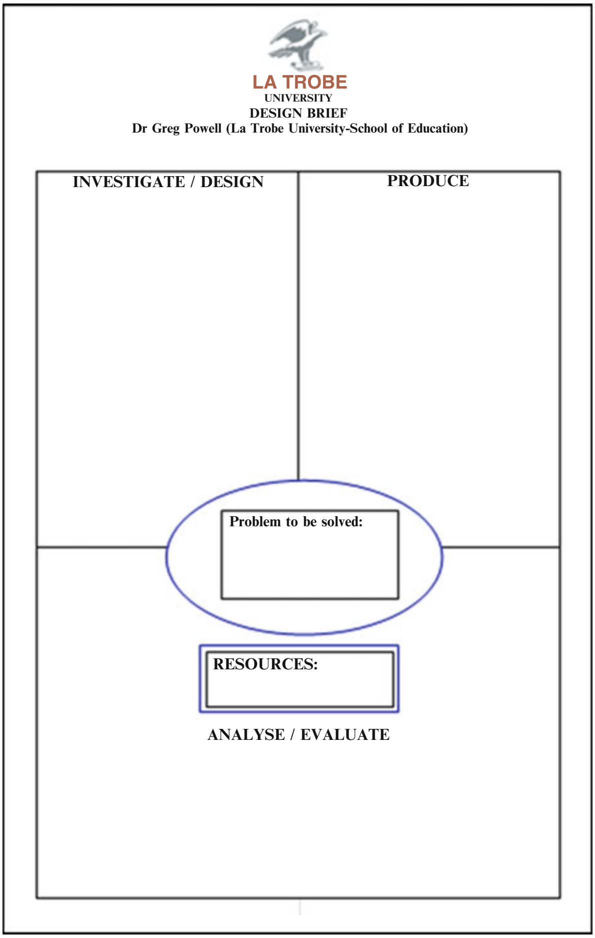

Fig. 23.3 Design Brief (La Trobe University, 2015)

and Lisanne de Jong developed after a 3 day intensive can be found here: http://reflectionkbarbaryedu4uml.blogspot.com.au/ and http://www.uml-lisannedejong.blogspot.com.au/.

These blogs demonstrate a creative use of digital technologies (i.e. Google Blogspot™) based upon student reflections including the use of other Web 2.0 technologies, software used in workshops, lectures and workshop content. The power afforded by such technologies and the educational impact realised by pre-service teachers when using such software for a global audience enhances their ICT understandings as well as the notion of online communities of practice. The inquiry, the creation and communication through the use of digital technologies enable collaboration, research practice, independence as learners and the construction of new learning.

Pre-service teachers have ownership in the development of creative solutions based on the content studied and are able to apply a range of design processes that combine media elements for a solution suitable to both the requirements of the subjects studied at University and their own personal needs. There is also an element of experimentation and choice in generating such creative ICT solutions. However there are many ethical and moral issues associated with the creation of such online Reflective Blogs (e.g. individual rights, cultural expectations, copyright, and protection of electronic information as well as the impact of such globally assessed ICT materials by others). And it's partly the responsibility of academics at universities to remind as well as inform pre-service teachers of their responsibilities in this regard. The use of digital technologies as tools for educational use in the twenty-first century enables pre-service teachers to develop new ways of thinking, inform others worldwide through personal reflection and feedback as well as providing creative and innovative pathways for their teaching practices.

Recommendations for Practice and Sandbox Experiences

Promoting the goals of excellence and equity has to be at the heart of every higher educational institution and school setting enabling students to become successful, confident and creative learners. The goals and outcomes can be delivered through, "New technology-based models of learning" and a variety of educational ICT tools (Dede, 2013, p. 48). Subsequently, pre-service teachers and school students are provided with a digital voice to choose from a range of technologies to assist their learning as well as for assessment purposes across a range of disciplines or subject matter.

Using a range of software tools provides essential elements to build twenty-first century computer literacy at the personal and professional level for students. Software use enables users to create, manage, store and work more productively. In the author's opinion what works best when introducing new software tools to pre-service teachers and students is to provide time for "Sandbox Experiences". That is, providing time for students to "play" and experiment with the software for a short period of time (perhaps half an hour-depending on the complexity of the software).

Example 1: Sandbox Experience Using Inspiration™

After the initial introduction where aspects of the software are demonstrated, the students spend time discovering on their own or in small groups what the various menu options enable them to create. After this initial period the author usually provides a context for work to be created through using the software. For example, introducing students to the software called Inspiration™, the author demonstrates key elements such as the floating symbols palette, the placing of the graphics on the desktop, the use of the linking tool and the line tool and the ability to hyperlink words that can be added under each graphic, line or text box. Time is provided for the cohort of students to "play" and "experiment" with the software. Movement by the teacher around the classroom, seminar room, computer lab or hub is important at this time as it provides immediate feedback for you as the teacher about students' confidence in the use of the software. Those experiencing difficulties can be assisted and questions answered expediently.

After this Sandbox time the author sets a context for the students to complete a task using the software. It may be that they are required to complete an Inspiration™ activity that highlights music, sport, education, science, mathematics, even ancient civilizations etc. Students are then required to move from their seats and walk around the room checking out what others have created. Apart from the obvious health benefits in having students move regularly rather than sitting for long periods of time, the author has found the experience enables collaboration and communication between students as they inquire of others how certain elements were achieved on the desktop of Inspiration™.

Follow up conversations with the whole group are important for gaining feedback about the experience and the value of such software to them as pre-service teachers, for example. Specific software elements are also discussed at this time such as creating, formatting, editing, deleting, inserting, adding sound, video, copying, saving (in different formats), and printing (in different formats). However the major benefit of such an approach lies in placing the students at the heart of the creation cycle in a context that is non-threatening. Through such hands-on software experiences pre-service teachers gain an appreciation of its application in their own teaching. These hands-on experiences are also of benefit at a school level for secondary or primary aged students.

Gaining software skills through non-threatening Sandbox experiences, enables users to develop confidence, to experiment, to be creative and positions students to be active inquirers and knowledge creators. This is in stark contrast to how software skills were taught to students and pre-service teachers in the past where the emphasis was on drill and practice.

Example 2: Sandbox Experience Using MS Excel™ and M&M™

Another example the author uses with pre-service teachers to think differently about the use of digital technologies that are currently available in most Victorian schools is the M&M Sandbox experience for literacy and numeracy using MS Excel and a small packet of M&M™ chocolates or peanuts.

Pre-service teachers are required to bring a small M&M packet to the workshop and the discussion starts with a partner to think critically about the colour of the packet, the weight of the packet and the information contained on the reverse side of the packet. Students are asked to consider appropriate questions about such information that could be used in a classroom environment. Questions like: How much does the packet weigh? Is there a relationship between the colour of the M&M packet and the dominant colour inside the packet (when opened later). What do the words Kilojoules, Sodium, Riboflavin, Calories, Saturated Fat, Fats, and Calcium mean? Such questions are shared amongst each group with much discussion.

Once the packet is opened the students perform a basic mathematics counting exercise to total the number of M&Ms, the coloured M&Ms are sorted onto paper with grids based on colour, and proceed to answer some of the questions stated above. Students then use their iPhones™ or Flip Cameras to capture the image before discussion moves onto the use of MS Excel™. A rudimentary demonstration occurs about MS Excel™ and use of the words "charts" (MS Excel™ term) as compared to graphs (Australian mathematical term). The author demonstrates how to enter data and create a simple graph/chart. Those students competent in the use of Excel™ can start immediately entering the data and creating the graphs associated with the M&Ms. For other pre-service teachers (not confident to use Excel™) the author demonstrates how this is achieved and then provides time for individual and paired sandbox experience as pre-service teachers enter their own data in MS Excel™ and graphing/charting the results.

The author shows the M&M™ (Australian website) and demonstrates how various M&M characters (Red, Blue, Green, Yellow) can be added as floating objects around and on top of the resultant chart/graph (Fig. 23.4).

A further Sandbox time enables users to refer to the M&M™ website for further data about M&Ms (history, packaging, production etc.) as well as further time to remodel their final MS Excel™ spreadsheets of data and charts/graphs.

Physical movement is permitted as pre-service teachers share their screens and discussion shifts to educational applications of such software in classroom environments with students. Discussion may involve how this task could be completed in classrooms with limited numbers of computers or digital devices such as tablets, iPads, etc., Other discussions involve around the use of interactive whiteboards and teacher driven options such as paper based use of Kindergarten Squares (i.e. small coloured square paper) and large sheets of Butcher's paper (enabling a model of a graph/chart to be created). Pre-service teachers are asked to reflect upon how students in schools could gather more data from across the whole school rather than just relying upon one classroom's set of data. Pre-service teachers upload their MS Excel™ sheets and screen captures as JPEGs into their blogs. They are then required to write about the activity and reflect upon the process, the use of software, key mathematical terms used and ways of implementing such activities into classrooms. At the heart of this Sandbox activity is the belief that ICT provides new pathways to engage and enhance the mathematical learning experiences for students.

An important element of this sandbox experience is to consider potential health issues associated with peanut allergies amongst students. Hence a brainstorming session follows where Pre-Service teachers are required to discuss how this Sandbox experience could be delivered in a classroom without using M&Ms. Usually pre-service teachers provide solutions such as using mathematical counters of different colours, or the use of Unifix™ Blocks, or even small coloured stars placed into

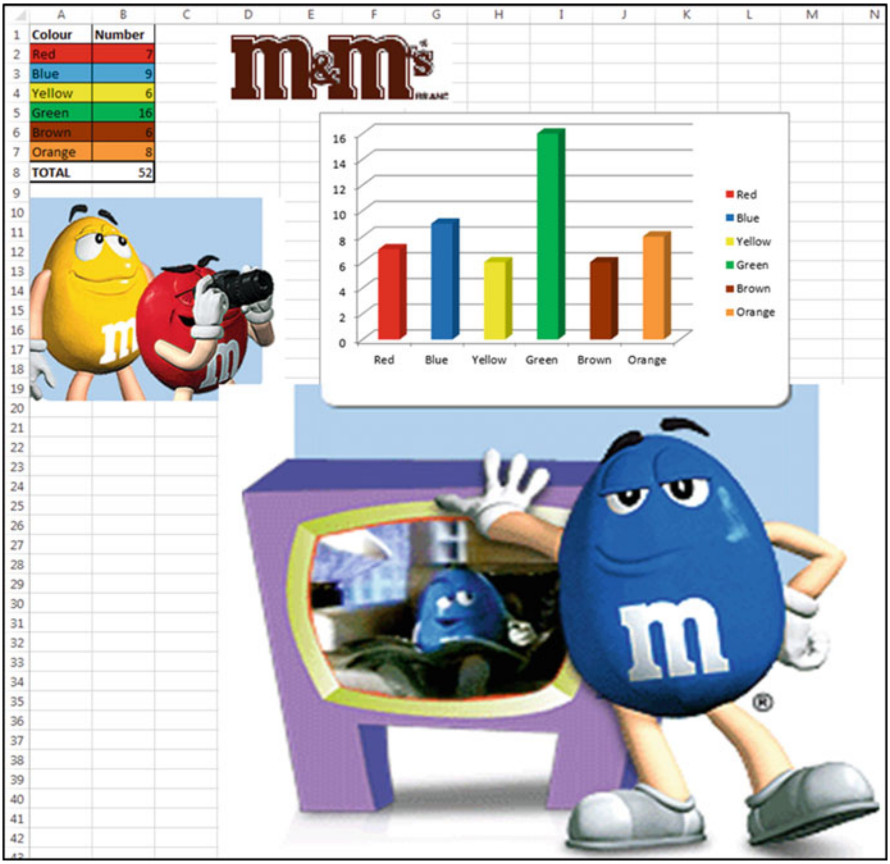

Fig. 23.4 Pre-service teachers example of MS Excel™ and use of M&M™ characters

envelopes (to replicate the M&Ms). Pre-service teachers then discuss the application of this MS Excel™ Sandbox experience to other mathematics classroom activities.

The use of MS Excel™ in this Sandbox activity provides insights for pre-service teachers to integrate real world experiences (i.e. use of M&Ms), improve ICT skills, develop further understandings linked to the Victorian curriculum AusVELS (mathematics) and how to plan sound pedagogical learning sequences across a range of integrated activities useful with much of the curriculum in use today.

Summary

The significance of Sandboxing experiences in using a range of technologies in education for pre-service teachers lies with the affordances they provide (i.e. networking, collaboration, communities of practice, editing, writing, reflecting, and the sharing of knowledge, ideas and opinions). In this chapter, the author has provided a background to twenty-first century education, the changing nature of learning and the use of digital technologies. The implications for assisting inquiry through the use of challenge-based learning and the practical use of Sandbox experiences for pre-service teachers to build new knowledge, collaboration and engagement have real world applications for the classroom. The Sandbox experiences strengthen and enhance pre-service teacher education experiences, provide new and powerful learning opportunities in use of software as well as providing authentic educational cornerstones for the twenty-first century.

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Victorian Curriculum (AusVELS): http://ausvels.vcaa.vic.edu.au/
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Websites: Educational Software Websites

ABC Splash: http://splash.abc.net.au/home#!/home
Flickr: https://www.flickr.com/
Go Animate: http://goanimate.com/
Inspiration (Visual Thinking and Learning Software): http://www.inspiration.com/
M&Ms (Australia): http://www.m-ms.com.au/default.aspx
Moodle: http://pukunui.com/au/mod/book/view.php?id=1&chapterid=3
PebblePad: http://www.pebblepad.com.au/
Presi: https://prezi.com/
Scootle: http://www.scootle.edu.au/ec/p/home
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www.wikispaces.com
www.wix.com
www.zunal.com

Websites: BLOGS

Down Under Teacher: http://downunderteacher.blogspot.com.au/
Google Blogger: https://www.blogger.com/home
Microsoft: The Australian Education Blog: http://blogs.msdn.com/b/education/

Websites: EXTRA Websites for Creative Building ICT

BuildYourWildSelf: http://www.buildyourwildself.com/
DeVolver: http://www.dvolver.com/moviemaker/make.html
Storybird: http://www.storybird.com
Tagxedo: http://www.tagxedo.com/
ToonDoo: http://www.toodoon.com/
Voki: http://www.voki.com/
Windows Movie Maker: http://windows.microsoft.com/en-au/windows/movie-maker
Wordle: http://www.wordle.net
Zooburst: http://www.zooburst.com/

Chapter 24
The Role of New Educational Technology in Teaching and Learning: A Constructivist Perspective on Digital Learning

Keith S. Taber

Abstract Constructivism as a perspective on teaching draws upon research into the nature of learning to inform pedagogy. From a constructivist viewpoint educational technologies are potential tools for enacting curriculum through particular pedagogic approaches. New technologies therefore add to the teacher's toolbox offering alternative ways to bring about learning within an established strategy. Digital technologies offer considerable new possibilities for the teacher, but should always be used as part of principled pedagogy rather than seen as ends in their own right. This chapter considers key features of constructivist thinking about learning, and offers some illustrative examples of situations where digital technologies have particular potential to support school teachers adopting a constructivist perspective to inform their classroom work.

Keywords Constructivism • Constructionism • Learning theory • Optimally guided instruction • Dialogic teaching • Educational technology • Teaching and learning • Constructivist perspective • Digital learning • Pedagogy • Constructivist teaching • Educational technologies • Tools • Curriculum • Pedagogical approaches • New technologies • Facilitating learning • Digital technologies • Teachers • Principled pedagogical approach • Principles of constructivist thinking • School • Teachers

Introduction

The availability of new digital technologies that can be applied in educational contexts is certainly to be welcomed. Such technologies are increasingly offering tools of immense potential to support classroom teaching and learning. For such tools to be widely adopted in a sustained way, and for them to be effective in supporting school learning, it is important that new technology is seen as offering useful

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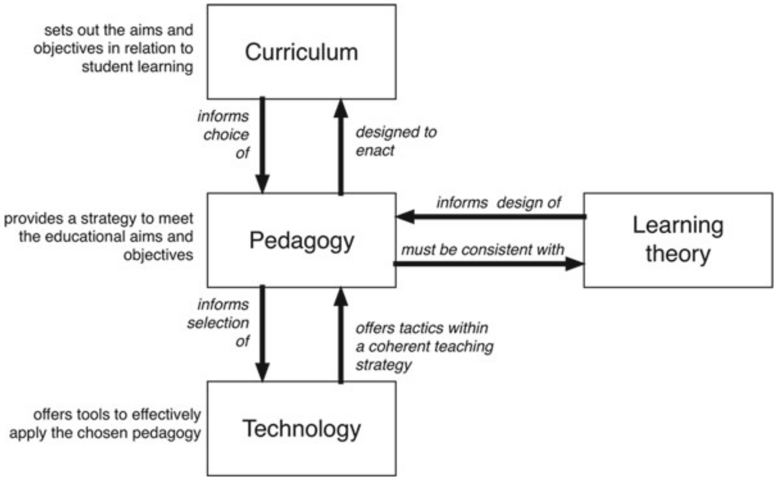

Fig. 24.1 The role of educational technology in the planning of teaching

solutions in response to genuine educational needs. The logic here should be in the direction of C → P → T (curriculum → pedagogy → technology), in the sense that teaching starts from curriculum in terms of the aims of the educational process, which are responded to through pedagogy—informed by theories of learning—and then drawing upon the most appropriate technologies (see Fig. 24.1).

New digital technologies can provide excellent tools to realise effective pedagogy that is enacted to meet desired educational goals—but it is important that teachers do not get seduced by the power or novelty of the technology or use it for its own sake. That will be obvious to most teachers, but the investment in new technology, the enthusiasm many students show for digital tools and media, and the temptation to be seen to be up-to-date and following educational trends, can all act as seductive drivers.

Teachers, like most learners, are unlikely to fully master new technologies immediately (Aldunate & Nussbaum, 2013), and will need to develop their pedagogic skills by testing out the use of new techniques in different contexts (e.g. in relation to different curricular aims and different groups of learners). This has been true whenever new technology has become available, whether that be roller chalk boards, overhead projectors, in-house reprographic facilities, cassette players, or wipe-off white boards. However, traditionally such advances in technology have been infrequent, allowing time for teachers to become familiar with the characteristics and affordances of the technology. Since the advent of relatively cheap and mobile computing devices which act as general-purpose programmable machines (which can be connected together through the Internet, so offering potentially infinite possibilities) the rate at which new digital tools have become available has been much greater. A new teacher today is faced with a constant flux of information about new tools ('apps', etc.) that could be adopted in the classroom whereas previous generations of teachers typically went years between major new technologies being available to facilitate teaching and learning.

There is then a risk of new technology being used in those ways which are, or can readily become, familiar to teachers, rather than in the most optimal ways (Mishra & Koehler, 2006). Teacher education and properly supported development in the use of technological tools are therefore essential. Moreover, teachers may resist innovations, such as unfamiliar new technology (Avidov-Ungar & Eshet-Alkalai, 2011). Teachers often tend to minimise the disruption to familiar and well-established classroom routines by assimilating the new into existing schemes and ways of working (Hennessy, Ruthven, & Brindley, 2005) in ways that may undermine the particular strengths of the novelty—with the danger of later inappropriately deducing that the innovation does not actually offer much, if any, advantage over previous approaches.

Teachers working in school systems tend to be assigned excessive workloads compared with most other professionals. A lawyer or a business consultant who was meeting with a group of clients would expect to be able to schedule considerable preparation time for that meeting. By contrast, most school teachers work with large and often diverse groups (often including some learners who would rather be elsewhere), and are expected to deal with a number of such groups during the school week—and to fit planning along with assessment, administration, professional development, liaison with various other professionals and parents, and sundry other professional duties, around a teaching timetable that often gives minimal breaks between their classes. Therefore, however well motivated and intentioned class teachers may be, the system in which they work necessitates that they prioritise their planning time—e.g. on topics not taught before, or on groups where there is an identified problem—giving them limited time for preparing many of their classes. The C → P → T logic (first revisit the aims of the course, and so the class objectives within more global concerns; consider the most suitable pedagogy to meet these objectives; then select the best tools to support that pedagogy) easily becomes short-circuited. Inevitably, much updating of teaching schemes is more superficial, and it is tempting for teachers to simply bring in new technologies as direct substitutes for what has gone before. Sometimes that may work well—but clearly a more principled approach is preferred.

So school systems are set up in such a way that some inertia is inevitable, and whilst schools as institutions generally welcome the new, there can be a tendency to adjust initiatives to fit custom and practice rather than to revisit that practice at a fundamental level (Hennessy et al., 2005). This is seen in the curriculum in some subjects where despite content being originally selected as instrumental to fit particular educational aims, it tends over time to come to be seen as somehow inherently essential to learning a subject. So in the sciences for example a particular industrial chemical process that was once seen as an authentic and socially relevant example of the application of chemistry, and that has been taught and assessed for many years, may be retained long after it ceases to be relevant to current industrial practice. Whether observing and evaluating teaching as an outsider, or reflecting on a lesson as a classroom practitioner, it is always important to start from a consideration of the particular educational aims the lesson is supposed to meet, to mitigate what might be termed 'practice creep'—the tendency to focus on, and over time modify and evaluate, a teaching activity in its own terms without regard to its original educational purpose.

Moreover, a teaching activity reflects the enactment of a particular pedagogic approach which should have been (originally) selected to respond to the educational purposes of the lesson. Pedagogy can be considered as the science or craft of teaching, and there is considerable research and scholarship on effective teaching and learning (Laurillard, 2012; Moore, 2000; Muijs & Reynolds, 2001). In particular, this chapter considers an area of educational theory sometimes referred to as constructivism which has been widely adopted as a basis for thinking about student learning (Novak, 1993). There is a range of often critical debates around the nature of constructivism, and what might be termed constructivist teaching (Phillips, 2000; Tobias & Duffy, 2009). This is unfortunate as the core of constructivist thought that is generally adopted in educational contexts derives from a strong theoretical and evidential base. These complications will be briefly addressed to clarify how constructivist learning theory is understood in this chapter.

What Is Constructivism?

The term constructivism is widely used across a range of different activities including philosophy, psychology, education, art, and research methods. The different uses are linked, but are not identical. This means that constructivism is sometimes associated with arguments about whether there is a reality beyond that constructed by the human mind, and whether objectivity is possible in research studies. These are important debates, but can be put aside when considering how constructivism is generally understood as an educational theory. There is no reason why a teacher cannot consider themselves as an educational constructionist despite their position—or lack of one—on such philosophical questions. Constructivism as an educational theory concerns what has been found out about the way learning occurs in human minds, and so is important in informing how teaching is organised. Digital technologies have been considered to fit well with a constructivist stance on teaching (Petko, 2012). This chapter briefly outlines some key features of constructivist thinking, how this can inform pedagogy, and some examples of how digital technologies can support constructivist pedagogy (see Fig. 24.2).

What Is Constructivist Teaching?

Just as there are complications over the different uses of the term ‘constructivism’, the notion of ‘constructivist teaching’ has been variously represented—sometimes leading to unfortunate associations (Bowers, 2007; Cromer, 1997; Kirschner, Sweller, & Clark, 2006). The understanding used here is simply that constructivist teaching is teaching informed by a research-grounded constructivist model of learning. Some scholars have attempted to variously characterise constructivist teaching as teaching by enquiry (which it certainly can be), ‘progressive’ teaching (but often when the

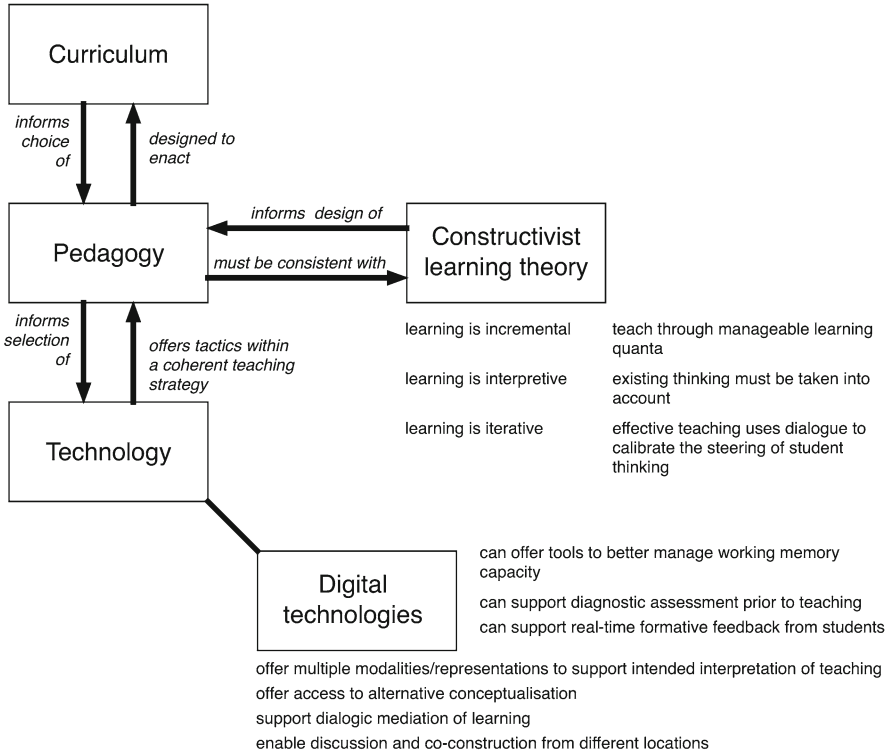

Fig. 24.2 Digital technologies offer affordances to support constructivist approaches to teaching

term is used in a derogative sense), discovery learning (which in an important sense it is, although not in the way critics often use this term), learner-centred (which it is in one sense, but again not always in the way suggested)—and minimally guided learning (which it certainly is *not*). An especially influential analysis has suggested that in effect constructivist teaching is synonymous with such labels as progressive or child-centred learning, and has chastised this type of teaching as having minimal direction from the teacher (Kirschner et al., 2006). However, this does not reflect the more common understanding of the application of 'constructivism' in education.

In the way the term constructivist teaching is used here, the term refers to teaching which is actively and carefully planned, which requires the active involvement of the teacher, and which is designed to be *optimally* guided (Taber, 2011). This implies that constructivist teaching does not inherently involve offering students high or low levels of guidance for particular tasks, but rather selects the level of guidance according to the particular task and learners. This is a key point as it relates to a key feature of good teaching, which is that it provides experiences for learners that are educative in the sense of neither being so routine as to lack challenge, nor being so demanding as to make substantive progress unlikely for the student. Such judgements relate to not only the task itself, but also its match to the learner's current state of knowledge and skill, and the level of support provided—either directly by the teacher, or through planned access to learning resources (for example, use of the Internet), or through the organisation of the class in such terms as student grouping (Taber, 2015).

It follows from this that in order to provide a sufficient level of challenge to make learning activities genuinely educative, a teacher may sometimes deliberately limit the support they provide during the activity, which might therefore seem to an observer as minimally guided teaching (but only because of the planned match of learning objectives, student, task demand, and resource). It is equally the case, however, that at other times, in order to provide a sufficient level of support to make learning activities genuinely educative (again in terms of the match between demands, students, and support in relation to particular objectives), the same ('constructivist') classroom would look very different, and would be seen to be very teacher led, with students receiving a good deal of direct guidance.

Constructivist Learning Theory

There is no single constructivist learning theory, but the basic principle of educational constructivism (sometimes called pedagogic constructivism or psychological constructivism) is that complex conceptual knowledge cannot be transferred wholesale between minds, but rather that conceptual learning is a process of constructing or building up knowledge. This sometimes leads to accusations of a relativist view of knowledge, that is, the view that all knowledge is subjective, and relative to a particular cultural or even personal viewpoint (Matthews, 2002; Scerri, 2003). However, as suggested above, constructivist teaching does not rely on any such philosophical stance about knowledge. The pedagogic constructivist perspective is simply responding to what has been learnt about the nature of human learning (Taber, 2013). It is not a prescription that everyone *should* be encouraged to develop their own unique take on the world, but rather a recognition that to some extent this is what inevitably tends to happen (Glasersfeld, 1989). Nonetheless, as discussed below (and see Fig. 24.3), there is also a recognition of the important role of social interaction that tends to channel people to think in similar ways.

Research on human conceptual learning suggests that it is interpretive, incremental, and iterative (Taber, 2014). Learning is interpretive in the sense that learners do not always understand the teacher as intended (as indeed is the case more widely in human interaction). The learner has to make sense of what they are shown and told, and can only do so in terms of existing experience, knowledge, and understanding—what might be termed the available interpretative resources. When what they are told does not seem to link to any existing interpretive resources, they make limited sense of it, and long-term retention becomes less likely, and can only be rote rather than meaningful (Ausubel, 2000). In practice, it is usually more a matter of the degree to which the learner can link teaching to existing resources rather than simply learning being purely rote *or* meaningful.

Learning is incremental in the sense that human cognition has a kind of system 'bottleneck' in the faculty known as working memory. Human working memory has

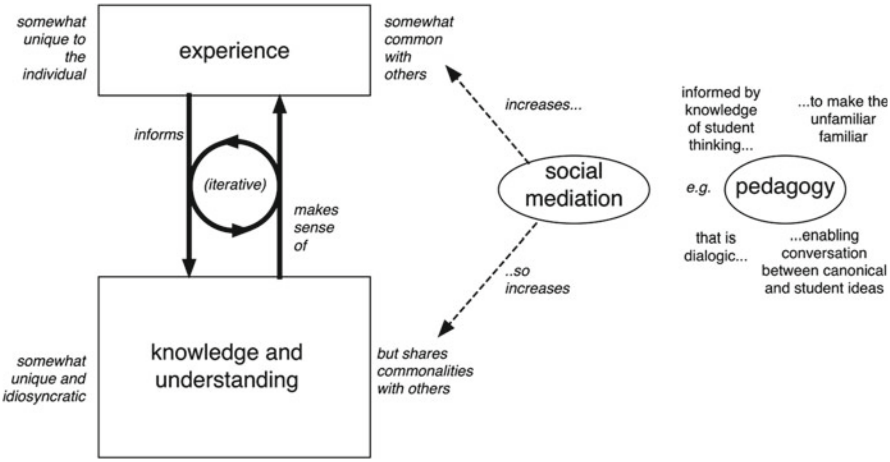

Fig. 24.3 The extent to which an individual's conceptual constructs match canonical knowledge is influenced by social mediation that allows the learner to be aware of, explore, and compare alternative conceptualisations

a very limited capacity in terms of the number of—what are termed—'chunks' of information it can handle. There is much filtering of sensory information (at a pre-conscious level, besides whether a learner is deliberately paying attention or not) before it reaches the level of the system where it becomes consciously available and can be processed in working memory. What counts as a chunk of information is however subjective, as it is linked to the interpretive processes referred to above. Material that is already familiar and well established in long-term memory can be handled as substantive chunks, and therefore the degree to which a teacher's speech or some instructional text (such as on a website) or the instructions for a learning task makes demands upon a learner's working memory depends upon the extent to which it can be understood in terms of prior learning. Two learners with similar cognitive capacities may cope with teaching very differently depending upon the extent to which they can interpret new information in relation to existing understanding. Effective learning has to be presented to learners in (what they find to be) manageable learning quanta.

The Importance of Learning the Tool Before Learning with the Tool

Digital learning tools can be either a burden or a valuable support in regard to the limitations of students' working memories. Any unfamiliar technology or tool (digital or otherwise) or process potentially compromises learning by burdening working memory. For this reason it is not sensible to introduce new technologies and tools (such as an unfamiliar application) in a lesson where students will already be challenged by the demands of meeting new content they are expected to master. Rather, learning to use a digital tool is a substantive task in its own right, and only when the tools are familiar can they become an effective means of supporting other learning. Certainly learning the tool should involve applying it in some authentic context, but the chosen context should be just that (a context) and not something that it is important for the students to learn about whilst familiarising themselves with the tool. So, for example, the context might be a relevant and interesting example, which is not specified as essential in the curriculum, or perhaps a topic that has already been studied where the activity can be seen as review of prior learning.

However learning to use and becoming familiar with such tools may be a sensible investment of class time if once mastered the tool can then support learners in overcoming the restrictions of working memory. This is a well-established principle—in the sense that something as prosaic as pencil and paper can be used as a tool to overcome working memory limitations in carrying out an elaborate calculation that has too many steps to be 'held in the head'. Digital tools often consider affordances in this sense. For example, data loggers in school science labs may partially automate the routine aspects of the collection of laboratory data (as is often the case in professional laboratories) allowing students to focus more on the concepts and patterns the practical work is meant to illustrate. It has been found that school lab work which is designed to support conceptual learning is often carried out with minimal engagement with the target ideas, partially because the need to focus on the manipulative work leaves limited capacity for the intended mentipulative activity (Abrahams, 2011). Digital technology can support learners in making lab work minds-on as well as hands-on. Sometimes (depending on the educational purpose of the particular lab activity), simulations may be more effective than actual laboratory work.

The same basic principle applies in many other areas of school learning. In a language lesson, translation between languages may be the focus of an activity where the teacher may be expecting the student's working memory to be occupied with handling a translation. But in a history class, for example, a student might find some apparently relevant text in a foreign language. Possibly the student could use a dictionary to attempt a translation, at least where they had some familiarly with the language concerned. This would require the application of their cognitive resources to the translation and would be time consuming. A student who had learnt to use a tool like Google translate could likely achieve as good or better a translation much quicker whilst leaving most of their capacity for thinking about the meaning of the text in relation to the historical issue they were studying. This is an example of a powerful tool that can be mastered very quickly—indeed the most important part of learning to use the tool is learning to appreciate that any translation between languages is potentially imprecise and needs to be treated with caution (e.g. an interesting exercise is to translate a phrase successively between several different languages and then back to the original language).

Supporting Teachers in Formative Assessment and Remedial Instruction

Learning is necessarily iterative as a result of being both interpretive and incremental. In some curriculum areas there is a good deal of research suggesting learners come to class not only often deficient in expected pre-requisite learning, but also often holding alternative conceptions of curriculum material (Duit, 2009). That is, learners may have their own ideas about how things are which are inconsistent with what is to be taught in the curriculum. If teachers do not spot this, then learners will often misinterpret teaching in terms of their existing alternative understandings, and so build up different meanings to those intended by the teacher.

Again this suggests ways in which digital technologies can best support learning. The iterative nature of learning complicates the work of the class teacher tasked with leading students towards canonical understandings of target knowledge. As learning is a process of knowledge construction, the teacher's lesson plan is based upon a model of the learners' current state of knowledge. If the teacher knowingly adopts a constructivist perspective for their work, then this will be an explicit model: otherwise it is a tacit model (where the teacher's planning makes implicit assumptions about students' prior knowledge and readiness for progression). The teacher is anticipating how the learner will interpret and make sense of teaching, based on their knowledge of the students' current levels of knowledge and understanding. No one has a comprehensive understanding of another's conceptualisations—so such a model is inevitably partial and not entirely accurate (Taber, 2013). Effective teaching is therefore an interactive process where the teacher is constantly seeking feedback on how learners are making sense of teaching, and adapting ongoing teaching accordingly—acting as a kind of 'learning doctor': diagnosing, hypothesising, and testing student thinking (Taber, 2014). This is recognised in the emphasis in recent years on the importance of formative modes of assessment—so-called assessment for learning, rather than just assessment of learning (Black & Wiliam, 2003).

The high level of interaction characteristic of the school teacher's work explains, in part at least, why notions of teaching machines that seemed promising in the mid-twentieth century have not led to the replacement of teachers—even with the advent and almost ubiquity of the modern personal computer. Yet this level of teacher-student interactivity is an ideal that it is very difficult to maintain in the classroom. Commonly, teachers use a wide range of questions as an integral feature of their classroom presentations of subject matter (Edwards & Mercer, 1987)—questions intended to check on attention, background knowledge, whether students are making the expected links with previous learning, whether students are appreciating references to everyday examples, whether they understand the analogies and metaphors being used, whether they might be inappropriately applying unhelpful common alternative conceptions to make sense of teaching, and so forth. Teachers ask these questions to inform decisions about the next pedagogic move: whether it would be best to proceed with the next phase of the lesson plan, give further examples, recap earlier work, etc.

This decision-making draws upon a diverse knowledge base: the teacher's knowledge of the subject matter, of subject pedagogy (pedagogic content knowledge), of the students in the class, and of the moment (cues about students' current state of attention, etc.). For an experienced teacher this draws upon accumulated learning from iterations of formal study and classroom experience. (The constructivist model of learning applies as much teachers as any other learners.) It seems very likely that the highly networked nature of the human brain facilitates 'online' classroom decision-making based upon a diverse and imperfect knowledge base (an area where human cognition is more suitable than machines applying linear logic and formal algorithms).

In practice the teacher usually carries out this process by questioning a small number of students. The teacher may make the choice of which student(s) to question using her knowledge of the class, or by a system that ensures that everyone has a chance of being asked, but relies on one or a few children being proxies for the class. In this context classroom response systems can be very helpful (Fies & Marshall, 2006). Where appropriate the teacher asks a multiple-choice question (either about student confidence in their understanding, or to test that understanding) and all students can respond discretely by pressing a button or touching an icon. Such a survey of the class falls short of interacting in detail with each child, but can ensure that the teacher has a much better overview of the levels of understanding at that point in the lesson.

Although computer-based learning systems lack the level of interactivity of a detailed conversation with a teacher, they can be used to complement the teacher in areas such as diagnostic assessment and remedial support. Research into student understanding and common learning difficulties in topics informs the development of diagnostic tests to use before teaching a topic (Treagust, 1988), and digital versions of these tests can support the busy teacher with ready collation and analysis of the data. Similarly, computer-based teaching materials developed for student use outside the formal classroom, can be used for remedial work, or where a student cannot attend a class. Drawing upon subject-based pedagogic expertise, these materials can offer some level of interactivity (Taber, 2010), based on subject experts' knowledge of the most likely errors and sticking points in a topic. The sophistication of such systems is increasing such that they offer increasingly individualised feedback to learners (Narciss, 2013).

Encouraging the Student to Be Active in Their Learning

Constructivist instruction is sometimes linked with learner-centred approaches to teaching. This association can be understood in part in terms of how constructivist learning theory acknowledges the inevitable individual differences in how learners understand teaching and build up their own knowledge (given their unique set of interpretive resources, based on their prior knowledge and experience). However, this should not be taken to suggest that constructivist teaching cannot be full class teaching—it rather means that the constructivist teacher does not teach as if all students will respond to teaching in the same way.

Another association is with notions of active learning. Again, however, it is not that a constructivist perspective suggests that learning 'should' be active, but rather that learning *is* by its nature an active knowledge construction process. The activity referred to is cognitive, and some kinds of learning commonly occur without conscious deliberate attention—although that is not the case for the learning of academic concepts. Constructivist theory suggests that students need to be actively processing during learning of conceptual material, but this does not necessarily require a student to be moving about or making noise, as students can be mentally active whilst sitting quietly listening to the teacher. (Of course the length of time students will be cognitively engaged in learning in such a mode varies with factors such as age, motivation, topic, and teaching style!)

What this sense of active learning does mean is that metacognition (Whitebread & Pino-Pasternak, 2010) can be very important in learning as students who examine and deliberate on their own learning are likely to actively process material in what are termed 'deeper' ways (Rhem, 1995). Digital tools that support learner metacognition can be very useful here. One example would be applications that allow students to prepare and modify (and track changes in) concept maps—although, as with all digital tools, it is important that the usability of the tool is such that student working memory capacity is not burdened by using the tool itself (Weinerth, Koenig, Brunner, & Martin, 2014).

This perspective also provides some support for the 'flipped classroom' model of instruction (Seery, 2015). The argument here is that traditionally much class time is spent with the teacher presenting, and students noting down, information that could be just as easily acquired from texts, to give learning that is then reinforced and checked through exercises carried out in private study when teacher support is not available. Whether or not this assumption is widely true in many school classrooms today (e.g. Mortimer & Scott, 2003), it seems to be sound in relation to many university lectures.

The flipped classroom movement argues that it is more effective to get students to do the reading before class, and spend class time on activities, such as working through examples, when there is peer and teacher support available. Although the principle has long been argued in terms of students making their own notes from books before class, increasingly digital technologies are allowing teachers to provide resources (such as videos) for pre-class work that goes beyond simple texts. In this context, the Khan Academy—an independent not-for-profit organisation in the USA—has made available a wide range of videos on many topics that students around the world can access through the Internet. There has been some criticism that sometimes these types of videos do not make the most of the affordances of technology—being little more than taped lecture segments—but even this offers some multi-modality (Jewitt, Kress, Ogborn, & Tsatsarelis, 2001) that is not available in a traditional printed text.

Social Aspects of Knowledge Construction

Although this theoretical perspective on learning (sometimes labelled 'personal' constructivism) focuses on the nature of individual cognition and considers learning as a process of *personal* construction of knowledge, its corollary is that learning of canonical knowledge (as in school) is very much a social process. Individuals are able to construct new ways of thinking about the world for themselves, and sometimes these ways of thinking are genuinely original (i.e., 'big C creativity'—and some culturally new perspective, model, theory, tool, school of thought, narrative genre, or whatever, is created). However all such learning is constrained by the available 'data' and interpretive resources.

Some of the interpretive tools people use to make sense of the world are based on implicit (that is, not open to deliberation) 'primitive' knowledge elements that form through the brain's ability to spot patterns and apply them as the basis for developing expectations about future experience (Smith, diSessa, & Roschelle, 1993). These knowledge elements are primitive in the sense that they operate early in the process of making sense of sensory information, and so are used in the stages of perception least accessible to consciousness. Such processes are considered to be fundamental to all conceptual learning, but a solitary person who relied completely on this mechanism to construct models of the world would by themselves reconstruct very few of the established cultural inventions of humanity.

Rather, socialisation processes, such as are institutionalised in formal schooling, and in particular the use of language and other symbolic tools—as discussed by Vygotsky (1934/1986)—allow learners to build complex explicit (i.e. open to conscious deliberation) conceptual schemes upon their primitive knowledge elements (Taber, 2013; Vygotsky, 1934/1994). The conceptual understandings learners build are dependent upon their interpretations of the ideas presented to them by others—such as their teachers (see Fig. 24.3). This is what allows there to be cultural reproduction, so each generation does not need to reinvent the wheel (or, say, the computer mouse). However, non-canonical ideas which learners meet (in the family or wider society, in their reading or television viewing, or on dubious Internet sites) are also available to be drawn upon as well as the canonical ones (Blackmore, 2000). So for example in a community with high levels of racial prejudice, or where illness is believed to be due to evil spirits or hexing, formal teaching will not be working within an existing conceptual vacuum. Moreover, the ready availability of various forms of social media can accelerate the spread of technically incorrect ideas as effectively as canonical ones.

Teaching and Learning as Dialogic Activity

Increasingly scholars have recognised the role of dialogue in teaching for clarifying, sharing, and comparing ideas and understandings. Dialogic teaching involves the exploration of multiple viewpoints in the classroom (Boyd & Markarian, 2011).

It could be suggested that in subjects where the curriculum requires the learning of specified authorised conceptualisations this would be less effective for teachers, and more confusing for learners, than simply focusing on the canonical ideas to be taught (Claxton, 1986). However, the constructivist perspective suggests that there are always likely to be multiple understandings of curriculum topics and teaching among a class, and addressing this requires making explicit, and exploring, these different understandings. Teachers need to make elicit learners' ideas, and then incorporate consideration of them in the classroom presentation (Duit, Treagust, & Widodo, 2008). Pair and group discussion work may be used to elicit or explore ideas given the usual limitation of only one teacher seeking to engage a large group of learners in dialogue.

Digital technology offers a range of tools to facilitate the processes of making explicit and exploring different learners' views: chat rooms, fora, wikis, student blogs, and so forth. The adoption of virtual learning environments allows the dialogic work of the classroom to be spread through time and space, as student home study tasks need no longer be seen as intended as solitary activities but can become interactive even when students are not easily able to meet physically outside the timetabled class.

A perspective closely related to construct*iv*ism is construct*ion*ism. Constructionism concerns people learning in the context of a learning culture that has a focus on constructing some form of artifact. This can be a physical object, but digital tools can provide virtual environments within which learners can work together to build new objects (Parmaxi & Zaphiris, 2014). Again, the increasing ubiquity of home computers and mobile devices connected through the Internet offers the potential for joint construction work to take place outside the classroom without students needing to be in the same physical space to work together (Watson, Murin, Vashaw, Gemin, & Rapp, 2011). School-age children today are often quite used to the idea of being virtually together and engaged in shared activities when physically apart, and with modern digital technology there is no reason why the social, dialogic, aspect of knowledge construction within a group has to come to an end when students leave the school premises for the day.

Conclusion

Technology offers tools that must be carefully chosen to fit particular purposes. Educational planning needs to begin with a consideration of our purposes, and then consider the strategy (i.e. pedagogy) to be adopted accordingly. Constructivist ideas are based upon work exploring the nature of learning, and how it can best be supported by teaching. Conceptual learning will be incremental, interpretive, and iterative in nature (Taber, 2014) regardless of the subject matter or the educational technology available to support teaching. Effective pedagogy therefore requires structuring what is to be taught through manageable learning quanta, finding ways to relate unfamiliar material to what is familiar to learners (and so depends upon knowledge of the students' prior ideas and understanding), and a dialogic approach that (a) allows students to explore and compare ideas and (b) gives the teacher ongoing feedback on the students' thinking to guide real-time decision-making about the next pedagogic move in the classroom. Digital technologies offer considerable affordances for supporting such pedagogic approaches, and increase the potential for school teachers to work as constructivist teachers.

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Chapter 25
Educational Technology Implementation in Ethiopian High Schools: Benefits and Challenges of the Instructional Plasma TV

Temtim Assefa

Abstract Educational technology is now widely implemented to improve educational problems in the schools and universities. Its main goal is to empower teachers with additional tools so as to improve learning in the classroom. This study was undertaken to investigate the success and challenges of instructional plasma TV in Ethiopian high schools. The study employed systematic literature review and case study research methods. Data for the study was collected using interviews, observations, and document survey methods. The samples for the study were selected using purposive sampling methods. The collected data was analyzed using thematic analysis method.

The study revealed that the instructional plasma TV integration in Ethiopian high schools brought some benefits for the students. Its multimedia content presentation attracts student attention for learning, simplifies complex concepts with visual demonstration, and helps teachers to upgrade their pedagogical skills by watching plasma teacher. However plasma TV is not without problems. The problems are classified as student, teacher, and technical related problems. The instructional delivery is fast and uses advanced command of English. These problems become a barrier for student learning. With regard to teachers, their role is limited to classroom managers rather than source of knowledge to their students. They cannot use their skills and knowledge to assist their students. Most of the class time is allocated for the plasma teacher. Technical problems like power interruption, class scheduling, and failure of plasma hamper the normal operation of the teaching learning process.

Empirical research on the impact of instructional TV on student learning achievement showed inconsistent findings. This is because of contextual factors such as school management, student background, and type of subject. The plasma TV improves learning because of its multimedia content presentation but its effectiveness depends on the contextual factors. For example in Ethiopia, most of the problems that are associated to barriers of learning from plasma TV are associated to contextual factors. Therefore, countries should thoroughly assess their capability before implementation of instructional TV as it is a complex process that includes human and technical factors.

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Introduction

The traditional mode of teaching, which focuses on mere knowledge transfer, is not appropriate to prepare students for complex modern society. Students should have problem-solving capability to be a competitive citizen. As Aginam (2006) pointed out, unless IT education is integrated into African educational system, the quest for global competitiveness may not be achieved. They reasoned that there is an urgent need to empower African youths with basic IT tools and knowledge that will need a long way in preparing them for the challenges ahead. The use of information and communication technologies (ICTs) in education is necessity and an opportunity for schools at all levels (Earle, 2002).

Every government recognises the benefit of educational technology. They undertake different measures to introduce educational technology and improve their student learning. This intervention ranges from introducing instructional TV to smart classrooms with Internet connections. The Ethiopian Government introduced new mode of teaching in the high schools through live broadcast instructional plasma TV (EEMA, 2007). It also installed one or two computer labs with Internet connection in all high schools of the country.

Despite such efforts, the contribution of educational technology to enhance learning is not as expected (Bitew, 2008; Sewagegn, 2013). One of the main problems is the focus on "techno-centric" intervention which assumes technology as a solution to all educational problems (Hendry, 2001). Developing countries like Ethiopia believe that technology can dramatically change their education by replacing teachers (Bitew, 2008; Osaretin, 2012; Schramm, 1973). It is through this mind Ethiopia introduced instructional plasma TV to replace teachers and modernise the delivery of their educational curriculum.

There are different empirical research on implementation, benefits, and challenges of ITV in education. The previous research is fragmented that does not give a holistic picture on application of instructional TV to teach students in the high schools. The result of the research will be used as input for policy formulation by governments and decision makers at different managerial positions. The study has investigated the following research questions:

How technologies can be used to improve educational quality in the high schools?

The specific research questions are:

- What are the main educational problems in Ethiopian high schools?

- How live broadcast ITV project was implemented to enhance learning in Ethiopian high schools?
- What are the benefits of ITV?
- Why ITV becomes a problem for improving quality of education in Ethiopian high schools?

Literature Review

Educational technologies are instructional media that are used to enhance learning (Earle, 2002). These technologies can include a variety of media like textbook, chalk and blackboard, radio, instructional TV, computer and Internet. The electronic form of educational technology started through broadcast of educational messages through radio. Ethiopia used radio to supplement its teaching learning process through aid obtained from US Agency for International Development in 1950s (Damtew, 2005). Ethiopian Government undertook radical reform in the delivery of education to senior secondary schools by introducing live broadcast satellite plasma TV receivers in 2004 (Melesse, Teshome, Simachew & Eshete, 2012).

Television use for instructional delivery has an old history. The USA is the first country to use educational television broadcasts in 1933 (Seels et al., n.d.). The oldest form of television use for instruction was a program transmitted by major public broadcasting organizations in the form of open-access programs serving specific groups, such as preschoolers, enrichment programs for school-age children, and adults who wish to learn new skills or gain new knowledge (Wolff et al., 2000). The USA is the first country to introduce instructional TV(ITV) in the 1960s with the purpose to increase the quality of teaching by replacing the traditional classroom teacher (Hendry, 2001). Television for direct instruction in primary and secondary education was adopted by some developing countries in the 1970s as "leapfrog" over problems of low-quality education by providing high-quality, centralised instruction with receivers located in classrooms, especially at the secondary schools (Wolff et al., 2000). Nigeria is the first country from developing countries to use television for education in 1954 (Olujimi, Biodun & Adefolake, 2011). The Nigerians introduced ITV to overcome the poor performance of students in science subjects that has been attributed to traditional methods of teaching and lack of well-equipped laboratory equipment (Osaretin, 2012). In Mexico, they used ITV to create educational access in remote locations where there are small students and difficult-to-attract teachers (Wolff et al., 2000). El Salvador introduced ITV in 1969 to modernise its education system. They started with pilot live transmission on 32 seven-grade classes (Schramm, 1973). Television and ITV as a medium of instructional delivery was used to address different educational problems in different countries. This implies that countries introduced ITV to address a variety of educational problems they specifically face.

Television is just a medium to deliver instructions. It provides a new way of information representation and provides alternative way of instructional content presentation to motivate and facilitate learning in the classroom (Salomon and Cohen, 1977). Television supports multiple sensory channels through its capability to present multimedia information which contribute to the ease of learning and also to the strength of retention of verbal information (Osaretin, 2012). The richness of multimedia information helps learners to view actual objects and realistic scenes, to see sequences in motion, and to view perspectives that are difficult or impossible to observe in real life" (Wetzel, 1994). However, the effectiveness of the ITV to enhance student performance depends on the design of the message. Teachers have an essential role in making successful any educational technology intervention. Money spent on school technology is wasted without an equal effort to help teachers with its use and integration into the curriculum (Zehr cited in Earle, 2002).

Television becomes effective if it is combined with other teaching activities. It should be designed in a different style than the normal consumer television and should be broadcasted for about 15 min just to establish a context for instruction and motivate student interest at the beginning of a lesson period while still allowing time to cover a curriculum topic (Hendry, 2001). Effective learning involves a social interaction between teachers and students as well as among students (Bitew, 2008). Instructional delivery should involve some kind of interactivity to engage students in the learning activities (Wetzel, 1994). Teachers are not replaceable by any technology (Bitew, 2008; Hendry, 2001).

The empirical research on ITV revealed both positive and negative impacts on learning. Educational reform with new curriculum, television, retrained teachers, new classroom materials, and new supervision through ITV in El Salvador resulted in better student learning than did the traditional learning system (Schramm, 1973). ITV improves teachers' teaching effectiveness and teaching methods by observing the television teacher (CCT, 2004; Schramm, 1973). It is also used to overcome the problem of shortage of qualified teachers especially in the remote schools (Schramm, 1973).

A research conducted in Nigeria revealed that the use of ITV in teaching science subjects enhances students' academic achievements (Osaretin, 2012). It motivates student's engagement in learning and develops a common base of knowledge among all students in the country (CCT, 2004). It helps to provide equal teaching opportunity for students in rural and urban areas (Schramm, 1973). Students nowadays are grown up in technology-driven society. ITV is the best way of motivating students to learn and increase understanding than the traditional teacher-led instructions (Olujimi et al., 2011).Television with its multimedia information provides multiple entry points into content, and thus offers greater accommodation to the many intelligences found in a diverse group of students (CCT, 2004). It also increases the attention span of learners and improves student's ability to memorise contents (Bitew, 2008).

Use of ITV in the classroom is not without problems. The research conducted in Côte d'Ivoire and El Salvador showed that the cost of delivery is expensive as compared to the traditional methods (Bitew, 2008; Schramm, 1973). The teacher is sitting in the classroom while the television lesson is in progress. The cost of live broadcast will always be an added-on cost to the fulltime cost of the teacher (Schramm, 1973) despite the scarcity of school resources in developing countries. It also promotes rote learning as students do not have the chance for interaction and reflection to construct their own personal meaning (Bitew, 2008). Administration of new instructional delivery also disrupts the normal teaching and learning process. Delay to quickly maintain failed TV sets, power interruption, and lack of adequate training by teachers to teach in the new mode of instruction are commonly cited problems that overshadow the benefits of ITV (Bitew, 2008; Osaretin, 2012; Schramm, 1973).

ITV was introduced to address different educational problems in different countries. Experiences gained in one country cannot be replicable to other country as each country has different environmental context and educational problems. For example, USA and Mexico introduced ITV to create education access in remote locations where there are no adequate and qualified teachers. Brazil used ITV to create educational access for school dropouts. However, developing countries like Nigeria, El Salvador, and Ethiopia introduced ITV to replace teachers and bring dramatic change in their education quality. However, this ambition is far from the reality on the ground. Technology is a tool that is used to enhance human capability. Technology without people cannot do anything. There are fragmented and in most cases non-reputable empirical research about the benefit of ITV on student achievement. Further research is required to fill the knowledge gap and confirm existing claims on use of ITV in formal education.

Research Methodology

The researcher employed systematic literature review and case study research methods because the research phenomenon is embedded with its context and requires investigation of contemporary issues (Myers, 1997; Yin, 2003). Case study research is also appropriate when the research requires deeper investigation about little known phenomenon through triangulated data collection methods (Yin, 2003). It allows understanding a phenomenon from the point of view of the participants and expressing in their own language (Myers, 1997). The researcher and the research respondents in collaboration construct the truth which has a higher correlation to respondents' understanding (Eisenhardt, 1989). Many successful models for ICT integration in developed countries don't work in developing countries mainly because theories are constructed from data which does not represent the realities of developing countries.

Triangulated data collection methods were used for the study, specifically interviews, observation, and document review. Interview is the most commonly used data collection methods in qualitative research (Yin, 2003). It was used to collect in-depth facts about how online satellite broadcast program was initiated, instructional material development, and implementation of the new instruction. Interview was also used to assess the teachers' and students' view about its effectiveness to improve existing educational problems and new challenges emerged as a result of implementing new instructional method. Three type of interview questions were prepared for project implementers, teachers and students.

Interview was conducted in 2014. The interview with students lasted for about 30 min and more than 1 h with teachers and program implementers. The interview at subcity and educational bureau was conducted by focused group discussion. The respondents were professionals nominated from different departments. For the purpose of confidentiality, the names of the respondent were not mentioned in the report.

Observation was used to capture data on live broadcast program, and teacher and student activity during delivery of live broadcast instruction. It is used to elicit data which cannot be expressed verbally. There was pre-prepared checklist for the observation of data collection.

Documents provide readymade information for a research. There are useful-to-capture historical records which are usually forgotten by respondents during the interview discussion. The researcher reviewed documents on online satellite broadcast project plan, committee minutes, evaluation reports, ICT policy documents, and other published materials in journals, conferences, and websites.

Qualitative data analysis involves identification and presentation of themes supported by quotes from participants' text as the primary form of analysis (Bazeley, 2009). The researcher used thematic data analysis method to identify important themes from the data. Initial themes were extracted from the research questions to start the thematic coding. When new theme emerges that does not fit to the existing theme, it is added in the list of themes. Finally the themes presented in narrative form to build the story of ITV implementation, benefits and challenges. The research findings were also discussed in light of existing literature to confirm existing claims on ITV or incorporate new perspectives to existing body of knowledge.

Research Findings

Education Problems in Ethiopian High Schools

Education is an important instrument to produce a skilled labor force for different sectors of the economy. Countries which can educate high proportion of their population in higher education are in the forefront of development (Yizengaw, 2004). In this regard, educational system should be designed in such a way that it can create conducive environment for delivery of knowledge in such a way that it can be easily assimilated by students. In 1994, the Ethiopian Government revised and issued a new educational policy that can address the country's development needs (MOE, 1994). The policy was intended to develop citizens with problem-solving capacity and support the country's development activities.

Ethiopian educational problems can be classified as infrastructure, instructional and motivational problems. With regard to infrastructure problems, there are no adequate classrooms in all high schools. The number of students is beyond the capacity of schools. Although the government opens new high schools and expands existing buildings, large class size remains a challenging educational problem. It is very common to have 70–80 students per classroom.

Ethiopian high schools have shortage of qualified teachers. In addition, teachers change their occupation for better payment to other organizations. The profession of teaching in Ethiopia is generally underestimated mainly due to low payment and low ladders for career development. The Ethiopian Government prepares textbooks for all subjects but the distribution is not efficient. In addition, there is shortage of resource to duplicate adequate copies for all students. The problem is worse to students in remote schools. In those schools, there is transportation problem to deliver on time and sometimes the number of students is not exactly known during distribution time.

Students mainly use Amharic and other local languages for day-to-day communication in the home as well as in the schools. However, instructions are delivered in English in all Ethiopian high schools. Student textbooks are also prepared in English. The students have difficulty to read and understand their textbooks. They have challenge to communicate and interact in English. Only students in private high schools can comfortably communicate in English and understand their textbooks. As a result students lack attention and show low participation in the classroom. They also failed to do assignments and have regular class attendance. Students show unnecessary discipline in the schools such as cheating during examination. Ethiopian educational quality is now the main agenda in many government and academic forums (Bitew, 2008).

Implementation of ICT in Ethiopian High Schools

Integration of ICT in the Ethiopian educational system is well underlined and is included in the policy document with clear objectives and strategies (EICTDA, 2006). Following the policy, the Ethiopian Government initiated three initiatives, namely Ethiopian National Schoolnet Initiative, the National ICTs Higher Education Initiatives, and the National ICT Education, Training and Awareness Initiative to integrate ICT at different levels of educational systems (MCB, 2006). Schoolnet initiative is aimed at deployment and exploitation of ICTs to facilitate teaching and learning process and implementing the new educational policy within the Ethiopian school system, including the primary, secondary, technical, and vocational schools.

The Prime Minister Office in 2003 initiated the Satellite Plasma TV project and ordered Ministry of Capacity Building (MoCB) and Ministry of Education to implement the project, a project that develops instructional TV programs to all educational systems: universities, colleges, Technical and Vocational Training Institute (TVET), agricultural colleges, high schools, and primary schools through live broadcast. The government also requested donor and lender organizations to finance such massive ICT project. However the donors refused the financial request because of the limited capability of the country to implement the mentioned massive project.

The government decided to use its own budgetary sources and continued with the project design and implementation. The objective of the ITV project was to overcome (1) shortage of qualified teachers especially in remote and inaccessible areas of the country, (2) shortage of textbooks, (3) inefficiency of teaching material distribution, and (4) traditional method of teaching that focuses on rote knowledge memorization; (5) to standardise delivery of education nationwide and create internationally competent students worldwide; and (6) to train youths with the new technology and prepare them for the twenty-first-century knowledge economy.

A committee was set up from different governmental organizations that have different professional mix to develop the project implementation plan. The committees were organised as technical committee who deals with technical matters such as selection of technologies and the other committee deals with content development.

The ITV live broadcast programs launched at one time in all Ethiopian high schools. This is a new project. It has risks of failure or success. In this regard, the respondent explained that:

> We raised this issue in our committee discussion. We suggested that it would be safe to implement this project through piloting. However, the decision makers said that Plasma programs are already tested technologies in other country and found workable, and there is no need to do piloting and waste time here in Ethiopia.

The first program was made in South Africa. The assumption was that South Africans have better English pronunciation skills than us. If students learn with South African readers, they will learn international pronunciation at early age so that they will not have difficulty to communicate with other English-speaking people or join other universities.

The program was also designed to be delivered through online broadcast. The role of the teacher was restricted to 10 min to provide introduction at the beginning of the lesson and summary at the end of the lesson. This approach makes the teachers idle. In this regard, the respondent stated that

> We have raised this issue in our committee discussion on duration of transmission per period. One period is 45 minutes. The committee suggested the transmission to be only 20 minutes and the other 25 minutes to be handled by the teachers. This issue submitted for decision makers. However, the decision makers decided that the live transmission to be 30 minutes, leaving 10 minutes for the teacher as the other 5 minute is warming up time. They reasoned out that the project incurred too much money and we should exploit the technology to its maximum capacity.

Although technology has benefits to enhance human activity, it cannot substitute a person. When we have a person that can handle the imaginative tasks such as teaching, we should give priority to the human agent than the technology. Live broadcast ITV is good when we have shortage of teachers in remote schools but it cannot be recommended as a panacea for all schools like in Addis Ababa where there are experienced and senior teachers.

All high schools received plasma TV. There is also one VSAT in each school that receives live transmission. In schools which do not have electric access, a generator was supplied. However, they were expected to buy fuel for generator from their school budget. This is a difficult decision as most of the remote schools have budget shortage even for purchase of chalks. The program started with live transmission of physics, chemistry, biology, English, and civics subjects for grade 10, 11, and 12 students in 2003 and two additional subjects of general business and technical drawing were added in 2007. Training of trainers on plasma utilization and maintenance was given for one teacher from each school. The trainers are expected to train other teachers in their schools. Through this training, schools develop a capacity to solve technical TV problems by their own.

The mode of delivery was decided to be through online broadcast transmission. Although the technology supports two-way interactions, it is implemented in one-way delivery. The main benefit of educational technology is to support individualised learning so that students can learn by their pace. With regard to this issue, the respondents stated that

> When I work as a committee member, we discussed the limitation of one way instructional delivery. We consider to distribute CD players so that teachers can control the delivery of the instruction according to their pace. If we propose this solution, schools need to have a CD player that can be connected with the Plasma TV. The government should also buy CD player for schools. This will increase the project cost. In addition, most of the schools don't have responsible person to handle CD players properly, there will be a risk of theft and interruption of instructional delivery. This option was rejected becuase of this reason.

Live transmission may not be effective for learning. It is very fast. Students may not have time to assimilate the new information and internalise as their personal knowledge. In addition, students have language problem to quickly follow up live program and effectively learn. In this regard, a respondent mentioned that

> We raised this issue in our committee discussion. Although students are slow to follow the pace of live transmission, they have to sacrifice themselves to improve their speed. If they continue by the present pace, they will remain slow learners, and this pattern should be stopped now. As a result the transmission is prepared to be average speed to improve students listening capability, not as fast as the native English speaking students and as slow as present Ethiopian students.

Learning is effective when there is two-way interaction between the learner and the source of the instruction. For learning to happen, students need feedback on their performance. One of the main criticisms for traditional teacher-led instruction is that teachers do not have adequate time to interact with all students in the classroom. It promotes rote learning. Live broadcast ITV will also have similar problem like the traditional teacher-based methods. In this regard, the respondent explained that

> The committee raised the issue and decided the program to be interactive by having intermittent questions and exercises in the lesson. The questions and exercises will be supervised by the classroom teacher. In addition, the committee also raised an issue to install a system that supports two way transmissions so that students can ask questions. This issue was abandoned because of the difficulty to implement it. The program is transmitted for about 120,671 students. This cannot be managable and the system is installed to work only for way transmission.

The ITV project implementation follows techno-centric approach to solve Ethiopian educational problems. Technology is considered as a solution to all educational problems of the country. Technology is good if it is appropriately used.

When we say appropriately, it implies that technology and people should be used in partnership to exploit the best features of the two agents. In Ethiopian case, ITV is assumed to have superior capability than the teachers.

Technology integration in education requires careful decisions on all phases of program development, implementation, and maintenance. Its success largely depends on teachers' commitment and ownership. Ethiopian ITV implementation decision is dominated by top-level decision makers. Of course any initiative cannot be successful unless the top management is convinced. But there must be clear boundary for roles played by decision makers and technical professionals. In Ethiopian case most of the decisions were made by top-level decision makers who do not have adequate knowledge on consequences of their decisions on the country's educational quality. Decision makers can initiate the idea and give directions. but the technical work and decisions should be left for the technical people to minimise risks of failures.

Benefits of Live Broadcast Instructional Plasma Program

A preliminary assessment by Ethiopian Educational Media Agency (EEMA) (2007) on the benefits of plasma mode of live transmission revealed that it has better coverage of curriculum, provides equal delivery of education (quality and content) to students in all parts of the country, has the ability to teach students in the absence of teachers in some remote schools where teachers are not available, provides student motivation through multimedia information presentation, improves time management, and improves students' English language skills. A similar view was also expressed through interview respondent

> Plasma live broadcast is good to support the lesson by visual demonstration to explain some technical concepts like digestion in biology class. This was not possible in the previous teacher led instruction. Our school does not have equipped laboratories.

The plasma mode of live transmission also develops the language skills of students and teachers. Teachers use mixed mode of instruction so that it limits language learning. The plasma teacher uses proficient command of English and this encourages students to have better English language skills. The content is presented both through visual and audio. It creates a learning environment that motivates and encourages students to develop their language skills. Kebede (2012) undertook a study in four senior secondary schools in Addis Ababa on the impact of live broadcast through plasma on English language learning. He used an ethnographic research method. The researcher's finding showed that ITV has a positive impact to improve student language skills.

However, the positive impact of plasma mode of delivery is not the same for all subjects. Sewagegn (2013) undertook an experimental field research to see if there is a difference between schools which use live broadcast plasma TV and the traditional teacher-led instruction on mathematics subject. He found that students who learn through plasma showed low performance and this is statistically significant. This implies that instructional plasma TV cannot be prescribed as a solution to all subjects.

Teachers have positive attitude on the use of plasma for instructional delivery. They believe that it improves students' language skills. However, teachers do not appreciate their roles as managers of classroom rather than source of knowledge to their students. Their role is restricted to organise and structure classroom activities and monitor students to follow up the plasma teacher. Kebede (2012) also revealed similar view on teacher's perception on plasma TV. He said that "… the technology has diminished their roles as teachers of English. Almost all the teachers are of the view that they are non-reflective implementers of the TV lessons rather than the inquirers; for the amount of time given to the classroom teachers is nominal that hardly allows them to enact their roles properly" (198). Sewagegn (2013) also reported that the role of teacher is limited to advising students to take notes when necessary, supervising students for activities given by plasma teacher, managing the classroom discipline, and giving a summary at the end of the plasma teacher lesson. This situation is now improved due to different research criticism and teachers have 20 minutes time out of 45 minutes class period.

Drawbacks of Learning Through Plasma TV

The Ethiopian instructional live broadcast to plasma TV receiver was not well planned in a way to address Ethiopian educational problems. Its implementation is a techno-centric approach. The instructional plasma TV was assumed to solve all educational problems. However, most of the project expectation was not achieved successfully. It was implemented as a political decision without considering the interests of teachers and students. As reported by teachers and students, the problems observed in the delivery of live broadcast instruction are organised as student, teacher, and technical problems.

1. *Student-related problems*. Students mentioned different problems on the delivery of live broadcast instructional plasma TV. First, the pace of transmission is fast. Although high school instructions are delivered in English, most students do not have adequate English language skills to follow up the live transmission. In addition, the level of language used by plasma teacher is also difficult for students. As one high school teacher explained:

   > You see for one thing the pace of the lesson is a bit fast. So here let alone to my students even to myself it is difficult to catch up with the plasma teacher (Kebede, 2012).

Second, it lacks high interactivity. Learning becomes effective when it engages students in practical activities. However, the instructional design for plasma transmission does not provide adequate time for student individual activities. The instruction has some activities for students to maintain the two-way classroom interactions. Students do not usually complete the activities with the allocated time. Sewagegn (2013) also revealed similar view why students do not like to learn mathematics through plasma TV. He reported that in the live broadcast instruction students do not have enough time to complete exercises, have difficulty in understanding the pronunciation of the plasma teacher and instructions in English language.

Third, instruciton design. The time allocated for different lessons is not based on complexity of the lesson. It allocates more time for simple lessons and short time for complex lessons. In addition, what is taught by plasma teacher and what appears in the national exam does not match (Kebede, 2012). This makes learning through plasma teacher ineffective. As reported by classroom teacher:

> The time allocation is not based on the complexity of the concept. As the teachers observed there is 40 minutes lecture and demonstration on some simple concepts but it rushes in five minutes on some other complex concepts.

2. *Teacher-related problems*. The teachers' role is underestimated after the Plasma instruction introduced. As a result teachers lack commitment to make the new instructional program successful. Other empirical research conducted on Ethiopian high school teachers' perception on plasma TV reported similar findings (EEMA, 2007; Kebede, 2012; Melesse et al., 2012; ; Sewagegn, 2013).
3. *Technical related problems*. There is frequent power interruption in the country. The interruption is accidental. If it is predictable, teachers may prepare and cover the lesson by classroom lecture. There is also no repeated transmission for those students who missed the scheduled transmission time. As a teacher respondent explained:

> You see—em when light goes off, everything will stop. Sometimes the plasmas fuse is stolen by some bad students. So you can't teach (Kebede, 2012).

Installing and running plasma is very expensive as compared to the traditional face-to-face instruction. The teachers are paid their full salary but the lion's share of their task is taken by the plasma teacher. The live broadcast instruction is an add-on cost for the Ethiopian Government. Technology becomes successful if it can reduce cost and increase efficiency. In this regard, the instructional plasma TV does not meet either one of the benefits.

Ethiopia is a big country with different climatic zones and federal government system. All schools do not have the same schedule. In some hot regions, there is no class in the the afternoon. However, live transimission is conducted during this time assuming that all schools are open through out the country. In addition, each federal region has some autonomy in its academic. They may not follow the central government academic calendar. Some programs of live transmission may not be attended by all students in the country.

Discussion

Educational technology has a lot of benefits for developing countries like Ethiopia where they have shortage of qualified teachers and laboratory equipment in all schools. Technology is a tool that is used to enhance human capability. But it cannot substitute the human expert (Bitew, 2008, Earle, 2002). Technology integration in the schools requires thorough planning to fully exploit the benefits of technology (Earle, 2002). Technological solutions are organization-specific solutions that cannot be purchased off the shelf and used like bread. In any technological implementation piloting is important to understand the limitation of the technology and fix it before we are implementing at its full scale. The history of instructional TV showed that all implementing countries started as pilot project before they undertook large-scale implementation (Osaretin, 2012; Schramm, 1973; Wolff et al., 2000). The Ethiopian case is exceptional which started with its large-scale implementation. This incurred a lot of cost on the quality of education of the Ethiopian Government.

The impact of instructional TV on student achievement is not consistent. It is generally assumed that instructional TV with its multimedia information presentation can motivate and engage students in their learning activities and increase retention of new information. Students expressed the benefits of instructional TV than the traditional methods of teaching. This finding is consistent with other researchers (Kebede, 2012; Schramm, 1973). Osaretin (2012) also reported that students who learn with instructional TV achieved higher in science subjects than the traditional teacher-based instruction. However, an experimental research conducted by Sewagegn (2013) showed a different result. Students who learn with face-to-face teacher in mathematics subject achieved better results than students who learn with plasma TV. This difference may be explained due to other external factors. Ethiopian students are poor in English and they cannot properly follow up the plasma teacher; on the other hand Nigerian students do not have English problems. This research also revealed that students prefer instructional plasma TV but they mentioned time management, language problem, and power interruption as barriers to effectively learn from the plasma teacher.

In addition, instructional TV is a best solution for developing countries like Ethiopia which cannot afford to provide one PC to one student technology access. In addition, there is also problem of having qualified teachers in all high schools of the county. This problem is worse especially in remote schools. Mexico also used instructional TV to provide educational access in remote locations where there is no qualified teachers (Wolff et al., 2000). Mexico was very successful in its instructional TV education program. It helps to prepare students to twenty-first-century knowledge-based society. However, the approach of replacing teachers to improve educational quality which is promoted by developing counties is a wrong perception. Teachers cannot be substituted anywhere and anytime but they have to be empowered with technology (Bitew, 2008; Hendry, 2001; Osaretin, 2012).

Conclusion

Technology is a tool that enhances human capability. If technology is inappropriately used, it worsens the problems rather than solving it. In Ethiopia and other developing countries, instructional TVs were implemented to replace teachers and drastically transform their educational quality. However, this is far from what is happening on the ground. Instructional plasma TV can improve student achievement if it is properly implemented and managed to address specific educational problems. Most of the problems on student learning through live broadcast instruction TV are associated with delivery management problems such as transmission pace, time allocation, and content design. This implies that if instructional TV is carefully planned and designed, it would facilitate learning in the classroom.

The impact of instructional TV on student learning achievement is not consistent. This requires further investigation whether the difference is due to contextual factors such as instructional delivery management problem, language problem, or subject nature. If these issues are clarified through empirical research, implementers will have clear understanding of how to effectively use instructional TV for student learning in the classroom.

Other researchers are recommended to undertake research on the impact of contextual factors on student achievement through instructional TV. There is also lack of adequate empirical research on instructional TV content design. The researcher recommends to undertake large scale study to prove the education benefits of live Plasma transmission program on student performance and on design of instructional content for live transmission.

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Chapter 26
Going Outside to Play: Managing Risk in the School Social Media Environment

Megan Poore

Abstract The use of social media in the classroom has become a major topic of pedagogical and practical interest in the educational literature of recent years. Although much of the literature addresses young people's online behaviour in general and the risks it exposes them to in everyday life, there is far less discussion about the need to manage the risks of digital technology use in the school environment. This chapter provides a very broad overview of some of the risks you need to manage—either in your own classroom or in your school as a whole—if you choose to take your students online and use social media as part of your school-based activities. The focus is on social media in particular rather than on digital technologies in general, and raises issues in relation to the use of externally hosted service providers. The chapter focuses on 'what' you need to do and 'that' you need to do it, but also covers some of the critical elements of things, i.e., why you need to do them. The chapter discusses professional development as well as the need to provide proper support structures, suitable risk management procedures, and an informed policy environment in your school if teachers are to experiment wisely and skill up steadily so that students can derive the much-vaunted benefits of using social media in their formal educational endeavours.

Keywords Risk • School • Social media environment • Online behaviour • Digital technology use • School environment • Teachers • Professional development • Support structures • Risk management procedures • Informed policy • Students • Teaching and learning • Social media

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Introduction

The use of social media in the classroom has become a major topic of pedagogical and practical interest in the educational literature of recent years. In particular, the benefits of using social media to engage students (Alexander, 2014; Di Blas & Paolini, 2013; Habgood & Ainsworth, 2011), encourage sharing and collaboration (Henderson, Snyder, & Beale, 2013; Pifarre, Guijosa, & Argelagos, 2014; Woo, Chu, & Li, 2013), and build community (Batham, Jamieson-Proctor, & Albion, 2014; Connolly, 2011; deNoyelles, Zydney, & Chen, 2014; Eteokleous, Ktoridou, & Orphanou, 2014; Montgomery, 2014) and even technical skills (Fu, Chu, & Kang, 2013) have been promoted and discussed, indicating that the use of digital technologies in schools is perhaps becoming the norm. And whilst there is a decent body of literature addressing young people's online behaviour in general and the risks it exposes them to in everyday life (De Zwart, Lindsay, Henderson, & Phillips, 2011; Depue, Southwell, Betzner, & Walsh, 2015; Gabriel, 2014), there is far less discussion about the need to manage the risks of digital technology use in the school environment. This chapter provides a very broad overview of some of the risks you need to manage—either in your own classroom or in your school as a whole—if you choose to take your students online and use social media as part of your school-based activities. As indicated, the focus, here, is on social media in particular rather than on digital technologies in general, and I especially raise issues related to the use of externally hosted service providers, although what can go wrong with external providers can also go wrong with in-house services. A lot in the chapter is taken for granted, and many terms are neither described, defined, nor even elaborated upon on the assumption that readers will search out further information for themselves. This means, then, that the chapter is primarily declarative in nature; that is, it focuses on 'what' you need to do and 'that' you need to do it; I also cover some of the critical elements of things, i.e., why you need to do them, but I leave it up to you to do some research into the more procedural elements of 'how' to do things. In the end, though, this is all about professional development and providing proper support structures, suitable risk management procedures, and an informed policy environment in your school for teachers to experiment wisely and skill up steadily so that students can derive the much-vaunted benefits of using social media in their formal educational endeavours.

Risk and Risk Management

There is a huge body of risk management literature that defines what risk 'is', but for now, let us simply say that a risk is a possibility of harm or damage occurring in a given circumstance; for our purposes, of course, the circumstance is having our students online. Within this definition, however, it can be easy to conflate risk with harm (Munro, 2010; Poore, 2016; Rysavy & Murph, 2015): taking a risk does not necessarily lead to harm, especially if the risk has been managed for. And for teachers and school leaders, it is essential that we manage risk to prevent, reduce, and limit the harms that our students might experience when using social media. This can be done by having a sound risk management plan that accounts for and controls people's exposure to hazards in your school environment (Fitzgerald & Steele, 2008). I won't go into details about how to set up a risk management plan for your school or for your in-class use of social media (you can Google it, instead), but suffice it to say that you *do* need such a plan. At base, you need to identify the risk ('There is a risk that X could occur'), identify what could cause the event ('Caused by Y'), and identify the consequences if the risk event were to occur ('Resulting in Z'). You should also calculate the probability of an event occurring and the impact the event would have on the various parties involved. Once this is completed, you should consider your mitigation strategies: How could you prevent the event? If the event were to occur, what would your response be?

Before you can put together a risk management plan, however, you need to be aware of some of the major areas that might pose risks to your school's or your class's use of social media, and that is the major focus of the remainder of this chapter. In particular, you should pay attention to legal issues, considerations relating to the service itself, and factors that might impact on teaching and teaching practice, so it is to them that we turn first.

Immediate Risk Management Issues

Legal Issues

Legal issues are usually front-of-mind whenever teachers think about risk in the online school environment; after all, who wants to be sued—ever? But with some proper analysis and understanding, it is quite possible to develop realistic school policies and robust risk management strategies for students' use of digital technologies (De Zwart et al., 2011; Howard, 2013; Ribble & Miller, 2013). As mentioned earlier, it is not my task, here, to provide you with a full description of *how* to implement things; rather, I point to the major areas of risk and leave it to you to look into each area in more depth.

The best place to start when considering legal issues is probably with questions concerning jurisdiction. Legal obligations vary from country to country and what counts in one jurisdiction might not apply in another. This has implications for when you sign up for a Terms of Service in that the laws pertaining to those terms may or may not cover you in ways that you do or do not expect depending on where you live. For example, the privacy or accessibility laws that govern Ireland may not apply if a breach occurs according to a Terms of Service that is valid only for laws that govern Canada. In this case, legal redress for a privacy breach may be limited. Can you manage such a risk? Understanding and agreeing to a Terms of Service suddenly become exceedingly important when these types of consideration are made.

Similarly, issues of copyright and intellectual property (IP) not only vary across jurisdictions, but they are also notoriously difficult to understand in any jurisdiction. Needless to say, then, you need to know how copyright is handled both in your country and by the host service under its Terms of Service, and any conflicts must be accounted for. You might also need to be aware of differences in how copyright is assigned by your organisation according to whether or not a person is a staff member or a student. Most students—of any age, and at any level—retain their copyright. However, for staff it is sometimes different. For example, some organisations require that staff members hand over their copyright as the organisation is paying them to do work for the organisation. Oftentimes, staff in this situation are permitted to keep their IP, but then does the organisation stake a claim in that, also? And if so, is that a claim to an exclusive right or a non-exclusive right to your IP? If your organisation has an exclusive right in your IP, then what happens if you sign up for a Terms of Service that requires a licence to use your IP to that service? In effect, you could be in breach of your contract with your organisation. Other issues relate to not only your own and students' copyright and IP but to third-party copyright. This is most often at issue when images or similar that are owned by others are posted by you or your students on your website. What do you know about 'educational use' clauses in such instances? Are you covered by them or not? Could using only materials released under Creative Commons licences provide a viable alternative?

In addition to copyright or IP breaches (either inadvertently by you or by others in the use of your own work), you need to consider privacy and confidentiality issues. Privacy laws also vary from jurisdiction to jurisdiction, so you need to be aware of such laws both in your own country and as they apply to a Terms of Service that you or your students sign up to. How does a company handle your data? What if students share each others' privacy information? How will you ensure confidentiality of student information? You might need to write up a Privacy Impact Statement before you are across this area of risk. You should also be sure that the service(s) you are using does not compromise you as regards the use of cookies and monitoring to track user activity, the sending of spam, and the granting of indemnities.

By now, all of this probably sounds if not entirely frightening, then at least reasonably alarming. But remember that part of your risk management plan is to assign a level and probability of risk to each risk item, and to anticipate any potential negative outcomes. The point made earlier about being sued represents an extreme circumstance: in most instances, you will be alerted to any breach (of copyright, privacy, and the like) and you can act immediately to address the situation. In the instance of a copyright violation, for example, the person in breach is usually firstly issued with a take-down notice; it is only when that notice is not acted upon that proceedings might step up a level.

If any or all of the above is bewildering, terrifying, or impenetrable to you, then you need to learn more about copyright, Terms of Service, and privacy laws and how they are enacted. Only then will you be informed enough to make sensible risk management decisions in this field.

Service Considerations

Once you have accounted for the various legal and privacy issues you might encounter when implementing the use of social media in your school or classroom, you will need to turn your attention to considerations under the Terms of Service. It is common for people to sign up to a site or service without much thought; but failing to properly read and understand the Terms of Service can expose both you and your students to a number of risks. In the first instance, you need to know how the service handles and secures your data and distributes your content: Who can access your data and under what conditions? Can you delete information—or, indeed, your whole site—if you need to? Other major considerations relate to communications and notifications from the service provider (Can you control them? Do they generate spam?), and possible changes that might be made to the Terms of Service, pricing, and similar (What if changes are made that now pose an unacceptable level of risk to your project, for example?). You also need to have an understanding of how cookies and monitoring are handled by the site, and by your browser in general, and what kind of browsing history you and your students are laying down as you move from page to page or site to site. It is also important that you and your students avoid data lock-in by only signing up to sites and services that use standard file formats—if you become dissatisfied with a service, you need to be able to export your data into a standard format (for example, xml, html, or opml) and then take that data to a different service.

And finally, there are other, less technical or legalistic, points of concern, such as business robustness, reliability, and longevity, and how often the service updates its software (too often and it can be difficult to keep track, too infrequently and it can lead to things going out of date), and how much—and what—it advertises. Along similar lines, you will need to keep an eye out for apps that offer in-app purchases, as many ‘educational’ apps work on a business model of ‘bait pricing’, in which apps can be downloaded for free, but then require users to make in-app purchases in order to access additional features or to move through a game, for instance.

Although simply being online poses a level of risk to any and all of us, most reputable services should not pose too many major risk management challenges to the informed teacher (Howard, 2013). A comprehensive and up-to-date risk management plan will account for, and mitigate against, the concerns raised above. Once you have begun to sort out some of these legal and service-related issues, you can start managing some of the more obvious, in-class risks. As with any teaching and learning episode, a good deal of thought should go into how things might play out in the classroom before you get students working on an assigned task.

Teaching and In-Class Considerations

A key risk management item to consider as regards the practicalities of using digital technologies—and especially social media—in your classroom is the requirement (or otherwise) for students to sign up to a site or service. Quite simply, you cannot demand that anyone submit to a Terms of Service that they do not agree with, so my advice is to never insist that students (or their parents) register, but rather to explain your reasons for asking them to do so and then to find alternative tasks or assessments for those students who choose not to sign up. You must also make provisions for backing up any site you own or administer and for how you will handle student backups—Can students backup their own work, or do you need to do it for them? What if a site or service that you use disappears overnight? Again, you can mitigate against this risk by taking precautions (see the tips section at the end of this chapter). Determining how students (and yourself) will get help and support when technical difficulties occur is also something you need to think about. The school's helpdesk or IT team might not help you because you are using a third-party device or service, in which case you could be reliant upon your own skill and expertise to fix any problems. You might also run into problems if you choose to use a site, service, or device that favours one operating system, platform, or browser over another; finding something fairly ecumenical as regards functionality and usability is essential here.

Student bandwidth quotas and firewalls at school and their internet access (or not) at home should also come into your risk management strategy. What if you set a task that requires large files to be accessed but neither the school's nor the student's home Internet can cope with them? Moreover, there is sometimes a difference between students' 'theoretical' and 'effective' Internet access at home, meaning that in theory they might have high-speed broadband in the home, but in effect they cannot use it because other members of the household have priority over it or the devices served by it. Setting a task or assignment that requires students to access the Internet outside of school hours might disadvantage those in such a situation.

A final teaching consideration concerns students' own use—as opposed to yours—of sites, services, and devices. You need to think about whether a student's work should be public or private to start with, and then about students' online profiles: How visible should they be? Should they be visible to each other? To the outside world? Only to you? What risks are involved? Not only this, but the visibility of students' work to each other should also be scrutinised, as should students' responsibility for work done under their own login details. And if you give students access to their own logins and permission to administer their own accounts, how will you manage the risk of a student making changes to an assignment after the due date? Or worse, how could you remove offensive material if posted by a student?

Managing the classroom environment has always been a complex task. Add to that the presence of social media and other digital technologies and things can become even more complicated. But as always, a systematic and comprehensive analysis of what you are trying to achieve (Hamblin & Bartlett, 2013), how best to achieve it, and how to keep everyone safe whilst doing so can only lead to successful, engaging, and intellectually prosperous classroom conditions.

Ongoing Risk Management Issues

So far, we've run through some of the more tangible risks that exist in the online environment for both staff and students. However, there are other risks that we face when taking our students online that might seem either a little more abstract (such as the risk of *not* getting staff skilled up online) or a little harder to deal with (such as the vexed issue of cyberbullying). This section deals with these difficult areas, and points, at base, to the need to weigh up the educational and pedagogical benefits of using social media in the classroom against potential exposure to objectionable online content and behaviour.

Cyberbullying

Perhaps one of the most disquieting elements of the use of social media amongst young people today is the potential for cyberbullying. Teachers are right to be anxious about how digital devices and media can be used as vectors for bullying, and given schools' duty of care to students, this area needs strong and effective school leadership, policies, and procedures if students are to be kept safe.

Most importantly, we must recognise that cyberbullying *is* different from 'traditional' bullying. Whereas traditional bullying has typically been limited to mostly 'schoolyard' interactions, cyberbullying can follow a child into their very bedroom as they become the recipients of belligerent digital communications via text or similar (Bauman, 2013; Juvonen & Gross, 2008; Shariff, 2008). Moreover, most definitions of traditional bullying point to the ongoing nature of the bullying; as concerns cyberbullying, however, a single instance of malice (such as the posting of a venomous message) can be replicated infinitely as it gets shared, liked, forwarded, and favouritted (boyd, 2011). On top of all this, we must remember that many forms of cyberbullying are flat-out criminal in most countries. Serious cases can lead to violence, threats of violence, extortion, harassment, hate crimes, and stalking. All are illegal. And in some jurisdictions, sexting, as practised by some teenagers, can be prosecuted under child pornography laws. In the end, then, we can say that cyberbullying is characterised by any hostile act directed towards another person that occurs using digital technology (Poore, 2016)—and inasmuch as digital technologies are an everyday part of school life, so too must schools learn how to identify and respond to cyberbullying.

As with all areas of risk, the training and education of staff and students up front are just as important as having technical responses mapped out for when things go wrong. This means that we need to be alert to the behaviours of both possible victims and possible perpetrators. As Hinduja and Patchin (2010, p. 3) point out, victims will tend to withdraw, will suffer ailments such as headaches or stomach upsets, will have mood swings, or will be anxious around digital devices and will be uncommunicative when asked about what's happening online; perpetrators, on the other hand, might laugh or snicker unexpectedly when using a computer or phone, become agitated when usage of their digital device is restricted, and close the screen they are looking at when someone comes near, and, like victims, they can be reticent about answering questions about what's going on online. The bottom line, say Hinduja and Patchin, is that "[i]n general, if a youth acts in ways that are inconsistent with their usual behavior when using these communication devices, it's time to find out why" (2010, p. 3).

Most schools, of course, already have bullying policies in place, but the way in which bullying is dealt with changes periodically; for example, there has been a general move in recent times from a 'punishment' framework to one based on restorative justice. But these measures are retrospective and from a risk management point of view something needs to have already gone wrong before action is taken. Better to manage the risk by purposely designing and building a vigorously enacted ethic of 'no bystanders' in your school before children get hurt (Campbell, Slee, Spears, Butler, & Kift, 2013; Price et al., 2014). This means that everyone in your community is empowered to intervene—in compassionate and informed ways—to stop any instance of bullying that they become aware of.

Dealing with bullying of any stripe is never easy, as emotion, blame, and accusation can cloud judgement and reason. But your school needs to seriously manage the risk of the mental and physical harm that can cause cyberbullying; and if you teach little kids who don't yet have their own personal devices, you still have a duty of care as regards cyberbullying, for today's schoolyard bullies can become tomorrow's cyberbullies once a digital device is placed in their hands.

Staff Digital Literacy

It is perhaps a truism to say that the risk of *not* doing something can potentially lead to as much harm as the risk of doing something. Bromide or not, we still need to examine both extremities of this statement as regards teachers' skill levels and knowledge in the digital environment. At the end of *not* doing something, it is becoming clearer with each passing year that teachers can no longer afford to exhibit low levels of digital literacy if they are to adequately prepare students for a future in which digital technologies are a central part of life (Buckingham, 2006; Davies, 2007; Freebody & Luke, 1990; Hinrichsen & Coombs, 2014; Luke & Freebody, 1999; Payton & Hague, 2010; Yelland, 2007), from communication to entertainment, to banking, and to paying taxes. And this is not to mention the risk of leaving kids behind because of a failure on the part of the teacher to keep up with digital developments in pedagogy. At the other end of the spectrum is the risk posed by teachers who show somewhat evangelistic tendencies when it comes to digital technologies, and who ask children to roam the Internet with impunity whilst exposing them to potential grooming, identity theft, bait pricing, and similar perils. This is where an understanding of what constitutes digital literacy is useful, as this latter teacher is likely to have what I term good 'functional' digital literacy, whereas the former is not (Poore, 2016).

Functional digital literacy is, perhaps, the first element of digital literacy, and simply means knowing how to sign up for and navigate a service, how to upload photos and add tags, how to invite friends, and how to do many of the many practical or functional tasks associated with being online. It is not guaranteed, however, that the functionally digitally literate teacher has the second element of digital literacy: that is, 'network' digital literacy. Network digital literacy involves an understanding of what happens to your data in the networked environment, of how to interpret Terms of Service, of the privacy and security implications of sharing data, and so on; simply being online a lot of the time does not guarantee that you know how to safely navigate such networked risks. But avoiding online environments is no help either, especially if one has an uninformed attitude based on the belief that if I don't understand something, it is therefore highly risky. A final element of staff digital literacy that impacts on a school's risk management plan for social media and digital technologies is what I call 'critical' digital literacy. This is a form of digital literacy that engages higher level cognitive skills to critique the world in order to transform it through engagement with the social, political, cultural, and intellectual life encountered online. It is about using skills of analysis, validation, interpretation, evaluation, and synthesis to create new meanings of the world. Of course, you don't need to have good functional or network digital literacy in order to achieve this, but likewise you cannot claim to be a fully digitally literate teacher without them.

To sum up, then, teachers need to be digitally literate across all three areas of digital literacy: functional, network, and critical. Staff who might be reluctant about or scared by online environments need to be brought up to date through proper training, whilst those who might prefer to 'go rogue' and expose their students to any and all digital milieux must be reigned in and similarly given proper training, which all ties in neatly with professional development (PD). Many teachers do not see this a legitimate area to get skilled up in. Again, we can be faced with somewhat polarised attitudes, where high-end users could figure that they don't need PD in online teaching and learning, and therefore could expose students to unacceptable Internet-based risks, and where lower end users might think that all this digital stuff is irrelevant, stupid, and dumbing kids down, leading to their own non-engagement and ever-decreasing digital literacy. Thankfully, a happy medium seems to exist with the majority of teachers who just want to do the best they can in a constantly changing atmosphere and who rely on a natural caution mixed with the odd 'controlled' experiment. In any case, improving staff digital literacy is an essential risk management strategy if we are to sensibly and morally provide for students' pedagogical present and digital future.

Digital Divide

The final somewhat thorny area in which schools and teachers need to consider managing risk has to do with what is known as the 'digital divide' (Green & Hannon, 2007, pp. 59–60). Originally coined to describe the 'haves' versus the 'have nots' as regards access to digital hardware and software, the emphasis on the digital divide has shifted somewhat in recent times (Dornisch, 2013; Green & Hannon, 2007; Hatlevik & Gudmundsdottir, 2013; Jenkins, 2006) as hardware, software, and, in most cases, connectivity have come down significantly in price, allowing most people to own one or more digital devices. The focus for now, then, is on access not just to machines and an Internet connection, but also to networks and to digital capital (Grant, 2007) and how that access can be used to build participation in meaningful social relations. The key words in this case are 'meaningful' and 'capital': I may have the economic capital to purchase hardware and an Internet connection, but I may not have the social capital to make the most of those resources whereby I am hooking into networks of expertise and getting advice and recommendations and help. Similarly, I need to be able to use my cultural digital capital by knowing how to communicate and engage appropriately with the technology. As Lyndsay Grant puts it, "[s]tudents who do not have the economic, cultural and social capital to achieve meaningful and effective engagement with ICTs out of school … may find themselves disadvantaged" (2007, p. 6). And it is this risk of disadvantage that we must try to avoid by helping children build their capital in the digital space so that they can participate fully in the social and cultural affordances of the Internet.

Although cyberbullying, digital literacy, and the implications of the digital divide might seem problematic—even 'too hard'—areas for schools, they nonetheless carry appreciable risk and must be accounted for in any comprehensive risk management plan. Again, building knowledge (based on fact and evidence, and not on anecdote and opinion) is essential if proper measures to mitigate against risk are to be implemented in your educational environment.

Tips for Managing Risk When Using Social Media in the Classroom

Before concluding, let me provide some basic tips for helping to manage and mitigate some of the risk involved in using social media in the classroom. If you are going to use a third-party service provider with your school or students, then you should at least choose a service that

- Is reliable, robust, has been around for a while, and has a track record of quality service
- Has secure protocols in place for handling users' private data
- Allows users to retain their copyright
- Does not require an exclusive licence to users' IP
- You can back up (using an in-built backup function, site sucking software, or whatever other option you come up with)
- Allows you to control email notifications
- Allows you, as site administrator, to delete inappropriate material and information
- Allows you to make the site, or parts of the site, private
- Will not delete idle data
- Uses a standard file format, such as html, xml, or opml
- Datestamps contributions and whose datestamp cannot be changed by anyone other than an administrator
- Provides the basic functionality you require for free
- Works in the major browsers
- Does not display inappropriate advertising (better still, displays no advertising at all)

For yourself, you should at least

- Have a risk management plan behind you whenever you decide to use externally hosted websites with your students (you can find an example in the handouts section at http://usingsocialmediaintheclassroom.wikispaces.com).
- Inform both parents and students about your classroom use of social media and get formal parental permission, if needs be.
- Inform your students and their parents about the implications of signing up for externally hosted web services.
- Educate your school community about cyberbullying and empower everyone to act upon instances of cyberbullying.
- Address any deficiencies in the digital literacy levels of staff and students.
- Never require students to sign up in order to complete their work.
- Regularly back up any site that you own or administer.
- Require students to keep html or other copies of their own work.
- Tell students how to turn off cookies and monitoring.
- Make sure that you understand Terms of Service, especially as they relate to copyright, IP, data security, and privacy.

Conclusion

It is understandable to feel overwhelmed by the thought of having to manage all the online risks that students might be exposed to when they are under our care. But perhaps that is the key point of this whole chapter, that we have a duty of care to our students and we cannot shirk that duty simply because 'the Internet is too hard'.

We must develop appropriate, informed, and robust risk management strategies for all areas of risk, ranging from legal, service, and teaching issues to the more humanly intricate problems caused by cyberbullying, poor levels of digital literacy, and the dual nature of the digital divide. Dealing with these complexities in the school environment *can* be achieved, but only if we take an informed and level-headed approach to risk management and develop flexible and considered responses *before* things go wrong. Using externally hosted Web service providers for school purposes should not be avoided simply because we lack the resolve to master fundamental risk management strategies as regards social media. Rather, taking responsibility for you and your students' use of social media in the classroom will help everyone navigate this territory more safely and knowledgeably. The whole point of schools is that education is everything, and that is no less true when it comes to managing risk in the online environment.

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Chapter 27
Pedagogy, Practice, and the Allure of Open Online Courses: Implications for Schools and Their Students

Anna Dabrowski and Jason M. Lodge

Abstract The society in which we live has been transformed by technology and the subsequent provision of opportunities for education, connectedness, and communication. Advances in Internet technology see the online milieu playing a ubiquitous and influential role in the education of individuals and communities, as possibilities for learning continue to be reimagined. As access to education continues to expand in the online realm, this chapter provides an overview of current and emergent applications of online learning, with a focus on the implications of these developments for the school sector. The focus of this chapter falls upon the expansion of massive open online courses (MOOCs), with attention afforded to their manifestations in the education system. In this context, we consider both the merits and potential detriments of MOOCs within school settings, and consider if online learning is suitable as a teaching and learning mechanism for an increasingly heterogeneous cohort of high school students. As some nations signal movement towards acceptance of online courses in schools, this chapter also raises a number of implications for the policies and practices of schools, and the quality of learning students receive.

Keywords Pedagogy • Students • Practice • Open online courses • Schools • Access to education • Online environment • Applications of online learning • School sector • Massive open online courses (MOOCs) • Teaching and learning • High school students • Policies and practices of schools • Quality of learning

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As part of the ongoing process of globalisation, people around the world are more connected than ever before. It could be argued that such connectedness has led to the emergence of collective aspirations (Appadurai, 2013; Rizvi, 2011), resulting in increasing numbers of individuals seeking access to alternate prospects that extend beyond their borders (Vertovec, 2011). The society in which we now live has been transformed by technology, which has added to a globalising of people today by augmenting opportunities for connectedness and communication, across and beyond borders. Importantly, technology plays an influential role in the education of individuals as it continues to connect and transform the opportunities afforded to cultures and communities (Harasim, 2012).

As a major driver of mobility, education is just one of many ways in which globalisation has impacted upon the aspirations of individuals, and access to education and learning continues to expand in the online realm. Since the establishment of the Open University in the UK in 1969, online learning courses and programs (Harasim, 2000) have become available across a myriad of disciplines and for a range of purposes, including education, language learning, professional development, and business management. Today, largely in part attributable to developments in Internet access, online learning has become ubiquitous in response to the busy lives of the modern individual. Increasing steadily since 1984 (Harasim, 2012), there are now a number of forms in which technology-mediated learning manifests, ranging from formal online courses (such as those mandated in the tertiary education space) to informal learning applications available on handheld devices and social media platforms. In response, universities around the world have acknowledged the desire for flexible learning, and expanded offerings of courses and programs to suit the needs of their clientele. Some universities in the UK now place enrolled distance learning cohorts at more than 50,000 students across 150 different countries (Balfour, 2013). Similarly, in the USA and Australia, online learning is increasing in popularity, extending access to individuals from numerous nation states.

Although online learning continues to grow in formal tertiary settings, there is simultaneously an increasing appetite for informal learning that has seen a significant shift towards the provision of flexible, free online courses. The development of massive open online courses, or MOOCs, has provided a pathway for individuals to engage with prestigious institutes such as Harvard, Stanford, Oxford, and Cambridge at no cost. With access to content delivered by some of the world's top institutions, it could now be argued that education and access to a global network of learning resources is no longer a privilege afforded to the elite. A reduction in the cost of Internet technologies has resulted in increased access to a global network of resources and tools, and importantly collaborative learning circles. Such access marks a change in the traditional culture of university settings. An increasingly heterogenous student body is signing up to partake in free online programs. These programs have been made available through several different networks including Apple's *iTunesU* and MOOC platforms such as *Coursera*, *Udacity*, and *edX*. Widespread access to these resources initially caused speculation about a significant upheaval in the delivery of higher education in the future (Daniel, 2012). While much of the hype surrounding MOOCs has now settled, the apparent need to revisit the methods by which students acquire knowledge at a post-secondary level is still a matter of some debate (e.g. Porter, 2015). There are increasing calls to 'disrupt' (as per Christensen & Eyring, 2011) or otherwise reimagine learning in post-secondary settings (Jacoby, 2014).

The aim of this chapter is not to revisit different interpretations of online learning, but rather to provide an overview of current and emergent applications of online learning, with a focus on the implications of these developments for the school sector. To do so, we will offer a case study of massive open online courses, with a focus upon their current uses and possibilities in the secondary school system. We will then examine their merits and detriments, and consider if online learning is suitable as a teaching and learning mechanism for high school students. Ultimately, we will argue that a movement towards wider acceptance of online courses in schools has a number of implications for the practices of schools and the quality of learning students receive.

Massive Open Online Courses

Initially developed around 2008, MOOCs are commonly attributed to a group of Canadian educators and researchers including George Siemens and Stephen Downes (Baggaley, 2013). Building upon work in open education such as the *iTunesU* initiative and the success of the Open University in the UK, the idea behind the development of this new approach was to provide open access to quality post-secondary education (Siemens, 2013). These MOOCs were based on the theoretical foundation of *connectivism* (Siemens, 2005): a conceptualisation of learning that promotes the idea that people learn online through co-constructing knowledge in a networked and digitally enabled manner. As such, the initial versions of MOOCs relied heavily on collaboration between students in a flexible digital environment. MOOC participants were provided opportunities to collaborate within a specific online system and beyond it. MOOCs of this type often encourage the use of social media and other forms of communication that afford collaboration between participants.

As the notion of the MOOC spread, other parties developed an interest. Prominent among those taking an interest were computer scientists Sebastian Thrun and Daphne Koller who saw opportunities for expanding free access to quality higher education. Venture capital followed and their work spun out of Stanford University into MOOC providers *Udacity* and *Coursera*, respectively. These new platforms for delivering MOOCs emerged that, along with *edX* from Harvard and MIT, garnered the attention of the higher education sector globally. The MOOCs delivered via these platforms differed somewhat from the original design of the early MOOCs in that they often relied on videos as a content delivery vehicle and multiple-choice quizzes as the major form of assessment. There was thus more of an emphasis on broadcasting and the ability of these MOOCs to reach a mass audience than there was on collaboration and co-construction of knowledge as in earlier versions of

MOOCs. The delineation between the two types came to be labelled cMOOCs for the more collaborative versions and xMOOCs for the MOOCs adopting a more broadcast-style model (see Siemens, 2013).

MOOCs generated substantial hype in 2012 and 2013, with *The New York Times* declaring 2012 ‘The year of the MOOC’ (Pappano, 2012). Despite the extensive international interest in MOOCs and their supposed potential to change the way higher education is delivered, there were considerable concerns with their design and with the claims being made about their possible impact. Bates (2014), for example, decried that MOOC designers appeared to ignore decades of work in online and distance learning and MOOCs were subsequently criticised for low completion rates (Haber, 2013). It soon became evident that MOOCs were not making higher education available to the world. Indeed, many of the people completing MOOCs were already highly educated (Milligan & Griffin, 2015), thus nullifying one of the more sensational claims about MOOCs: that they would democratise higher education. In all, it became apparent that MOOCs were not living up to the promises made by their proponents.

Since the peak of the MOOC hype, there has been more sophisticated examinations of the role MOOCs might play in education in an ongoing way. There has, for example, been considerable research conducted on aspects of student learning behaviour in MOOCs through the analysis of various digital footprints left by students in MOOCs (Reich, 2015). For example, de Barba, Kennedy, and Ainley (2016) examined the roles that motivation and self-regulation of learning play in the process of learning in MOOCs. Using a combination of self-report data and digital traces left by students participating in MOOCs, they were able to conduct a nuanced analysis of the ways in which participants engaged with different aspects of the MOOC. In addition to the work being done with learning analytics in MOOCs, there is also a more thorough examination of how MOOCs might work for bridging or remedial instruction and how MOOCs might fit within a broader discussion about the future of credentials in an increasingly networked world (e.g. Lodge & Lewis, 2015). As such, it is important to understand the ways in which MOOCs are now beginning to find a place within the ecosystem of education.

Promoting Opportunities to Learn

Since emerging in 2012, MOOCs have extended beyond their initial hype towards reaching a state of embeddedness within the education system. The potential for MOOCs to augment the experiences of younger learners is now being explored in a number of OECD nations, including the UK, Australia, and the USA. Current discussions continue as to whether MOOCs could be used as formal credit for subjects taken in secondary schools. This move is unsurprising, particularly in the USA in which social advantage is often gained through educational access and enrolment in advanced courses that prepare students for college and university (Cooper & Sahami, 2013; Rivard, 2013). For students seeking alternates to the education predicated in traditional classroom settings, MOOCs may offer a response to low levels of differentiation, particularly for students who wish to engage in more advanced engagement with content.

Yet, although access to high-quality multimedia material in MOOCs has the potential to supplement the resources available to teachers and students in their context, the use of these open resources is not straightforward. Using material from or giving credit for MOOCs could be problematic, given the policy discourse that surrounds both the school sector and the education profession in general. Indeed, if we look to recent education reforms in Australia and the USA, emphasis upon teacher quality, national curricula, and the enactment of national teaching standards have dominated debates around 'quality education' (Australian Institute for Teaching and School Leaders, 2015; Dinham, Ingvarson, & Kleinhenz, 2008; Snoek, Swennen, & Van der Klink 2011). Many of these reforms are steeped in research that correlates improved student learning to instructional practice, with teaching quality and the classroom teacher now seen as key to bolstering student outcomes.

Accordingly, as policy now moves to capture the impact of newly qualified and experienced teachers upon student learning, any movement away from traditional classroom teaching is likely to be viewed with suspicion by many educators. However, it would be remiss to discount the merits of online learning and MOOCs for school students, particularly if we are to shift the focus away from academic achievement. In this light, online learning offers a means to promote engagement with content, and augment existing opportunities to learn. Although MOOCs are often taken by already educated individuals, they also purvey an accessible form of online learning to students who may have not previously engaged in formal or continuous education. It is in this context that we see MOOCs as a potential support mechanism for students. This extends to learners who may face difficulty in accessing a wide range of content, such as those undertaking distance or home-based education, or even students living in rural settings (Internet access permitting). Moreover, for students affected by disability, MOOCs offer a way to engage with a wider range of content without added attendance barriers or participation in non-mainstream school settings.

These benefits extend beyond the student, to the school and classroom level. In Australia and the UK, many state schools, particularly those in diverse socioeconomic settings, rely heavily upon department funding in order to access adequate resourcing. A lack of resources can influence classroom practices and the enactment of the intended curriculum (Ramsey, 2000) and importantly disrupt the quality of education students receive. Funding and access to resourcing, including professional learning, contribute to a lack of professionalisation, which impacts upon the attitudes of teachers towards their profession, creating a cyclical problem for educators and students alike (Dinham, 2013). However, MOOCs offer free content, orchestrated by some of the world's top universities, and for this reason are clearly desirable to schools that are struggling to receive funding.

If we examine current provisions to improve teaching consistency across federalised systems like Australia, MOOCs may even bridge gaps between equality of access and subsequent opportunities to learn. In Australia, socioeconomic status, rurality, and, in many cases, indigeneity act as barriers for engagement and achievement with the broader school community (De Bortoli & Thomson, 2010; Klenowski, 2009). This extends to schools, teachers, and learners, all of whom are dependent upon adequate resources. Finally, students from a myriad of cultural backgrounds may benefit from free online courses as a way to participate in collaborative learning and access a wider range of content. MOOCs, like other forms of online learning, are a useful way for students to engage with languages other than English, either as a foreign language or as a means by which to maintain mother tongue languages and dialects. In Australia, like the UK, language teachers are in scarce supply, and undertaking a language is not as common as in other OECD nations. MOOCs respond to the problematising of language learning in monocultural nations such as Australia where mastery of the English language is still the predominant driver of linguistic capital.

Despite the benefits that MOOCs might provide in each of these circumstances, there are some barriers to overcome before they could become seamlessly integrated into the broader ecosystem of education. For example, an underlying issue that has not yet been explored is the concept of motivation. Against a backdrop of possibilities and imaginings of MOOCs as a means to access a wider range of content, motivation is online learning spaces requires further analysis. As is evident in the work of de Barba et al. (2016), research into the learning experience in MOOCs is beginning to address these issues but there is some way to go before it is evident that MOOCs can help solve some of the pressing equity issues we have discussed.

Some Caveats: Motivation, Retention, and Quality

One of the most concerning and controversial issues surrounding MOOCs is the low levels of completion (Haber, 2013). Many MOOCs are based on time-based tasks, rather than competency-based learning, which at least partly assume that all learners are motivated, independent, and able to complete activities within a designated period. This may be a relatively safe assumption to make when the target audience for MOOCs is adult learners who have intrinsic motivation to participate and complete an MOOC. However, not all school students are autonomous; many require support from their school, teacher, parents, and peers. The type of environment created by MOOCs may therefore not be suited to the more structured and scaffolded learning environments that school-age students are both familiar with and are responsive to.

Motivation is therefore an important factor to consider if credit is to be given for MOOCs: at present, attrition rates for online learning courses exceed 90 % (Gaebel, 2014; Rivard, 2013), with less than 10 % of those enrolled ever completing the selected program. The struggles of online language learners and the issue of motivation and attrition are well documented in recent studies, with low levels of satisfaction with the course being undertaken often cited as rationale for discontinuation of online study (Clow, 2013; Halawa, Greene, & Mitchell 2014; Yang, Sinha, Adamson, & Rose, 2013). However, the major unresolved issue is the lack of regular, face-to-face support that is offered in a traditional classroom setting: an important element in countering the frustration and confusion of the learning experience, something many participants enrolled in online courses face (Conole, 2013). Although much of the existing research around attrition and motivation has examined adult learners, we argue that the outcomes for school students undertaking study without regular support from their classroom teacher would be comparable, if not even more problematic.

A further issue with MOOCs relates to quality and consistency. As nations such as Australia move towards the implementation of national curricula and national teaching standards, examining the quality of instruction and the design of the intended curriculum will be problematic. Negotiating the online learning environment and giving students credit for MOOCs offered by overseas institutions may require recognition of equivalency against prescribed content and common achievement standards. In school settings, these are outlined by individual curricula and assessment authorities. As yet there are no such controls in MOOCs. Against a myriad of policies that seek to maintain a consistent approach to teaching and learning, existing accountability measures provided by online learning providers would require much adaptation. Within the school system, online providers would need to demonstrate an understanding of targeted pedagogies for students, with mechanisms to support and monitor progress through prescribed content.

At first glance, MOOCs appear to create a number of benefits for school students but also raise some issues. In the broadest sense, students are able to access material designed and delivered by some of the best university professors in the world. In addition to providing students with insight into the content of a range of university programs, free online courses also afford the provision of a cross-cultural perspective on learning, connecting to other course participants from around the world. MOOCs also pose an alternative to school-based and external learning interventions for both struggling and advanced students, offering a supportive mechanism to reinforce and promote access to content. Yet a move towards wider acceptance of MOOCs as a standard measure of attainment raises a number of issues.

Another Form of Tracking?

While free open online courses continue to both show potential for use in secondary contexts and raise issues in the process, it is evident that they are already having an impact outside the formal curriculum. It appears as though secondary students are already engaging in MOOCs, particularly in the USA (Cooper & Sahami, 2013; Rivard, 2013). Free online courses are now being taken by high school students to supplement their study at school. The reasoning here pertains to the lack of access to advanced programs, which in effect 'hold back' students who have been recognised for their academic potential. This is particularly problematic for students in comprehensive, as opposed to tracked or ability-grouped, school systems. In comprehensive systems, such as those found in the Anglo models of Australia, the UK, and North America (Reay et al., 2008), pedagogies and the enacted curricula are designed to facilitate a comprehensive approach to learning that ultimately focuses upon academic achievement and transition to tertiary study. In contrast, in tracked or streamed systems, school students are separated by their academic potential or performance. However, even within comprehensive systems, ability grouping may occur (Brunello & Checchi 2007). In the comprehensive school system of the USA, ability grouping remains common, particularly as a means to augment the opportunities of high-achieving students (Moller & Stearns, 2012). *Advanced Placement* courses, a form of tracked learning, culminate with college-level assessments that aim to increase students' chances of gaining entrance to North American universities (Bryan, Glynn, & Kittleson, 2011). As a consequence, ability grouping has become one of the most defining aspects of the American education system with the availability of Advanced Placement classes in schools operating as a means to bolster student enrolments and instill social prestige for a select few (Boaler, Wiliam, & Brown, 2000).

In Australia and the UK, tracking or streaming students based on ability is not a formal policy, and MOOCs may offer gifted students an opportunity to undertake more rigorous work in a flexible learning environment. Indeed, this already appears to be occurring with students supplementing their formal education with MOOCs and other online resources (Yuan, Powell, & CETIS, 2013). However, although proponents argue that ability grouping responds to the need to differentiate between students, there are also concerns that tracking can lead to inequality within the education system (Mühlenweg & Puhani, 2010). As such, extending online learning opportunities and integrating them with the formal curriculum could also be problematic, in that it will make available access to content for some students, but not others, simulating a form of tracking. The potential implications for unequal distribution are numerous, with responsibility for the appropriate enactment of MOOCs resting firmly within the hands of school administration.

Pedagogies, Practices, and the Future of the 'Teacher'

As we have outlined, there is much potential for using content developed by faculty at the best universities in the world in a secondary school context. With more quality content available online every day, it would be a missed opportunity not to take advantage of this content. However, the benefits of providing access to advanced content for high-achieving students, as well as those affected by disadvantage, remain unclear. With so much talk of standards and curriculum-based reform in the UK, the USA, and Australia (Snoek et al., 2011), the ability of online learning courses to assist students to meet the learning outcomes of their secondary education is an issue that must be negotiated before schools embrace the concept of offering online courses as formal credits for classroom subjects.

Assessment is therefore a key focus. With much of the assessment regime in MOOCs relying on peer judgements and multiple-choice quizzes, questions remain about whether these approaches are valid and reliable enough to ensure equivalency with established standards. In a country like Australia, assessments have been developed to promote critical thinking and analysis, and there is little room for direct instruction or fact recall in the secondary school system, as these instructional and assessment strategies would leave students ill prepared for engagement with the tertiary sector. However, at the basis of this conversation is the continuing role of the teacher. Given the complexity of working with secondary school students, and the responsibility that continues to be placed upon educators in informing student outcomes (Hattie 2015), we would argue that a lack of trained secondary teachers working in the online learning space is the greatest challenge facing the mainstreaming of MOOCs into secondary education. Ultimately, teachers remain best placed to design and develop an effective curriculum for students and make qualitative judgements about whether students are meeting the required standards, particularly as teachers are considered the most important in-school influence on student engagement (Darling-Hammond, 2012; Hanushek & Rivkin, 2012; Hattie, 2012).

Deepening content knowledge, differentiating between learners' abilities, improving understanding of curriculum frameworks, and negotiating pedagogy against educational policies and practices are some of the many issues facing teachers working with a heterogeneous student body and particularly for those working to prepare students for life outside of the classroom (Waldron-Moore, 2013). Subsequently, allowing schools to substitute teachers for online learning platforms would be a mistake, as classroom teachers are well versed in the use of strategies that support student engagement and attainment. Professors from elite universities are generally not: despite possessing expertise in their field, not all professors are trained teachers and rarely have expert knowledge in the use of appropriate teaching methods for secondary students. Without this knowledge, even the best MOOCs might provide mismatched learning experiences for secondary students.

However, it is important to acknowledge that MOOCs offer opportunities for teaching staff to demonstrate and engage in peer modelling, in which pedagogy and practices around the world can be viewed in the form of an open online course. Indeed, many educators face uncertainty about what it is to teach, and for both newly qualified and established educators, MOOCs may provide an atmosphere in which teaching faculty can collaborate and develop skills together. In this case, the potential value of MOOCs in the school sector rests heavily upon the manner in which they are implemented.

Mainstreaming MOOCs

There is undoubted value in the use of MOOCs within the high school sector; yet embedding online learning in schools will take much effort. Ultimately, the purpose of MOOCs needs to be taken into account: they act as a mechanism that has enabled learning via large-scale collaboration between participants studying material developed for post-secondary education, rather than targeting the needs of school students. Thus, in order for this to work effectively at scale, students will need to be able to access the intended, taught, known, and assessed curriculum, and negotiate this with teachers and peers.

It should also be acknowledged that MOOCs have diversified significantly since emerging in 2012 (see Brooker, Corrin, de Barba, Lodge, & Kennedy, 2016). Topics that are of broad interest have been developed into courses that showcase talented teachers, researchers, and the institutions they represent. Others are targeted at a particular cohort, for demographic or professional development purposes. However, despite their diversity, MOOCs must be carefully monitored for inclusion within the classroom. Some MOOCs might be relevant to advancing the opportunities and outcomes of secondary students, while others may rely heavily upon motivation in contrast to developed and effective pedagogy. Yet differentiating between 'quality' MOOCs remains a complex task, with more than 2400 courses now available (Anders, 2015). Education's underlying impetus is to provide consistency in learning for students. The underlying problem with giving secondary students credit for MOOCs is that it remains unclear as to how online courses, and the manner in which they are delivered, interpreted, and understood, integrate within the existing curriculum. It is currently not possible to provide a fully personalised learning experience for students to help them develop towards generic and specific outcomes through the formal education system. Until that is the case, there will be an ongoing demand for students to supplement their formal education while governments and other stakeholders seek to standardise both curriculum and student learning progress across all levels of education. MOOCs may play an important and ongoing role in providing supplementary material for students outside the classroom and within it. In both circumstances however, the use of these resources needs to be managed carefully. MOOCs were developed as a way of democratising and opening up higher education, so the application of them to other levels of education requires careful consideration and further critical examination.

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Chapter 28
The Potential of OERs for K-12 Schools: Why Policy Is Crucial to Success

Ann Marcus-Quinn and Tríona Hourigan

Abstract There is a growing body of work advocating the use of open educational resources (OERs) to enhance teaching and learning across all sectors: primary, second level and third level (Boyle & Ravenscroft, 2012; Ljubojevic & Laurillard, 2011; Smith & Casserly, 2006). The role of OERs in the development and improvement of teaching skills is also growing. However, there are still barriers preventing teachers from integrating OERs into their classroom (Ertmer et al., 2007; Taylor, 2008; West & Victor, 2011). One possible solution to overcoming these barriers is raising awareness of ICT and recognising the potential of OERs either by placing an emphasis on them during accredited initial teacher education programmes or through continuing professional development programmes aimed at existing teachers. Both national and international repositories (JORUM, MERLOT, MIT Open Courseware) offer educators free access to high-quality teaching resources which have been designed and developed by educators for educators. Therefore, the OERs are primarily pedagogically driven and not driven solely by the available technology. The majority of these OERs in these repositories are also shared under an open creative commons license allowing equitable access to all. This chapter discusses why it is necessary to put a policy in place to actively advocate and promote the use of OERs at second level.

Keywords Open educational resources (OERs) • Ireland • Repositories • National services • K-12 schools • Teaching and learning • Barriers • Classroom • Initial teacher education programmes • Development programmes • Policy • Second level

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Introduction

This chapter seeks to provide an overview of ICT use in second-level schools in Ireland. It also aims to identify the various national and international open educational repository services that have been/still are available at an international level for the last 15 years. The chapter looks at Ireland's level of engagement with these services. The purpose of this is to show that while Ireland does have a policy in place regarding the use of open educational resources (OERs) at second level it is extremely limited and does not take advantage of the vast array of open educational offerings that are available.

Historically, Ireland had performed well in OECD academic league tables. In 2009 however, there was a marked decline; Irish students fell from 5th to 19th place in literacy and numeracy and that one in four 15-year-olds were considered functionally illiterate. The results of PISA, 2012, tell a very different story, based on tests undertaken in 2012 by 510,000 students internationally including about 5000 in Ireland; the outcomes of these tests saw an improvement but Ireland cannot become complacent. Irish students have shown the most improved performance in science, and Irish students performed above the OECD average, and climbed five places on the table. This may be the result of the introduction of science to the primary curriculum in 1999 and changes to the Junior Certificate syllabus in 2003. Irish students also performed better in maths, where they are ranked as 13th out of 34 OECD countries and 20th out of 65 countries. The Minister for Education, Rúairí Quinn, welcomed the improved scores by Irish students, but said: 'We cannot be complacent. While we are doing well, we are not among the top performers internationally, especially in relation to maths, where our students are scoring just above the OECD average' (Quinn, 2013). We have had two new ministers for Education in the past 24 months and it is likely that there will be another general election in the next 12 months. Without political stability and an established Minister for Education it will be impossible to put in place any policy regarding digital reform.

Public bodies and the teaching profession in particular carry a large percentage of the responsibility for assuring the success of the nation's education enterprise (Hamilton, 2013). If we are to improve Ireland's ranking in the OECD academic league tables or at the very least try to retain our place we need to look at how we are exploiting the available technologies when compared to our European neighbours. This chapter challenges the lack of national policy for the use of international open educational repositories and the vast amount of learning resources that they offer. While acknowledging that some progress is being made it argues that without a national policy incentivising the use of OERs we cannot expect to compete with our European neighbours in the arena of digital literacies. It is recognised that OERs are beneficial and there is extensive support of the value of OERs in the literature (Horn, 2013; Kay & Knaack, 2005; Leask & Pachler, 2013; Marcus-Quinn & McGarr, 2015; Nokelainen, 2006; Underwood, 2009).

In many countries at third level the use of digital teaching resources has been incentivised. For example, in Ireland in 2010 the status of the National digital

Learning Repository (NDLR) changed from that of pilot to a mainstream service (Marcus-Quinn, 2013). One of the significant changes to the service at this point was that the NDLR became a funding body for innovation in teaching and learning. Lecturers and teaching staff at third level were encouraged to apply for funding to develop OERs which could then be shared and repurposed if necessary. The NDLR Service was embedded in all 21 teaching and learning centres at third level in Ireland. The NDLR supported the enhancement of the quality of teaching and learning strategies, pedagogic approaches and innovative and effective deployments of digital learning objects through the NDLR user support model. This model is 3 Stage Evolutionary Pathway for supporting NDLR users (McAvinia & Maguire, 2011).

The NDLR provided a comprehensive network for supporting teaching and learning centres nationally facilitating sharing of expertise and learning resources both nationally and internationally. These networks helped to improve quality through constructive critical peer review and reduced costs by reducing duplication of effort across the sector.

The service supplied academics and students with free access to high-quality resources and subject networks from both Irish and international centres of excellence and held over 28,000 digital resources. In addition to the teaching resources the NDLR service (2009–2012) also funded and co-hosted over 400 national and internal teaching and learning events in conjunction with other higher education sectoral initiatives and professional bodies including ILTA, LIN, DRHEA, Flexible learning IOTI, Shannon Consortia and Atlantic Alliance.

A successful service promoting the sharing and dissemination of digital teaching materials should aim to serve the needs of all stakeholders. The following strategic aims set out by a previous UK project (BECTA) are worth observing for any national service aiming to deliver an effective service to facilitate the sharing of digital material to enhance teaching and learning at any level:

- Improve learning and teaching through the effective and embedded use of ICT.
- Increase the number of educational institutions making effective, innovative and sustainable use of ICT.
- Improve the availability and use of high-quality educational content.
- Develop a national coherent, sustainable and dependable ICT infrastructure for education.

Given that this type of incentivising activity has been proven to work at third level there is a strong argument for implementing a similar support structure for primary and post-primary education. We are in an era of rapid change in Ireland (Hamilton, 2013). It is encouraging that the new junior cycle of post-primary education in Ireland is changing. The new Junior Cycle Student Award (JCSA) will be rolled out subject by subject between September 2014 and 2022. From 2014, the new junior cycle will feature newly developed subjects and short courses, a focus on literacy, numeracy and key skills and new approaches of assessment and reporting. Schools will have more freedom to design programmes that meet the learning needs of all students. However, it remains to be seen if the new JCSA will be as progressive and innovative as it is being sold. The teaching and learning methods employed are still at the discretion of the school. How do we ensure that there is some level of innovation? How do we ensure that we do not just get another version of the old Junior Cert model but without the terminal exam? One possible way of avoiding such a reality is raising awareness of ICT and recognising the potential of OERs by placing an emphasis on them during accredited initial teacher education programmes.

As part of the Junior Cycle reform short courses are being introduced because schools have asked for more flexibility and freedom in developing areas of learning which connect with their students' interests and needs and with their communities. The NCCA is developing a number of sample short courses. These can be used 'off the shelf' but schools will also be provided with supports to help them in developing their own. Over time, it is expected that all schools will take the opportunity to innovate and develop their own short courses to an agreed template. There will be lots of short courses developed both by schools themselves and by external agencies. It is important that schools consider what kinds of short courses best fit their aims and vision for junior cycle education and best meet their students' needs and interests.

In 2012 the NDLR was invited to participate in a tender with the Irish Computer Society to provide OERs to the post-primary school sector in Ireland. This bid was successful and so the opportunity to have a central repository at the heart of digital learning across two of the three education sectors in Ireland was lost. However, another project, Scoilnet, was supported. The difficulty with developing projects and subsequently having them disappear is that resources become inaccessible. For example, some of the multimedia poetry resources which were available on Scoilnet are still indexed but not accessible. This can be very frustrating for users of the repository. The minister for Education and Skills relaunched the department's official education portal in May 2014, when questioned about the efforts being made by the Department of Education to ensure that all resource material and relevant textbooks relating to the school curriculum at primary and post-primary level are made available to teachers and pupils. Quinn asserted that it is the responsibility of the Board of Management of each individual school to decide on school policy in relation to the use and choice of textbooks. While the department promotes the use of ICT schools are not obliged to use OERs in their classrooms.

Why Are Irish Schools Reluctant to Avail of International Repositories and Other Offerings?

In a 2011 study carried out in a number of Irish post-primary schools Marcus-Quinn and McGarr examined how a teacher-designed multimedia resource for the teaching of English poetry was used by a number of teachers. None of the participating teachers had used digital teaching resources in their classrooms before this and were nervous about doing so. All of the participants reported that they benefitted from using the digital resource. The project did however raise a number of important questions relating to national ICT policy and the future use of ICT in schools. One of the major findings of this study was that the challenge for schools is to now consider how the technology will be used to best effect. Will technology be used to support the existing didactic system as a tool to enhance the teacher's presentation or will it be used as a tool to support more independent learning and exploration amongst students? The history of ICT integration to date would point to the former. In looking at schools over the decades Hargreaves identified a 'basic grammar' of schools that appears to survive societal changes and attempted innovations in schools;

> Behind all the autonomy, attempted innovation and educational expansion, a basic 'grammar' of teaching and learning persisted where most teachers taught as they had for generations, from the front, through lecturing, seatwork and question-and-answer methods, with separate classes of age-like children, evaluated by standard paper and pencil methods
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> (Hargreaves, 2003, p. 4)

The Teaching and Learning International Study (TALIS) report on Ireland, published in 2009, supports these earlier findings reporting that 'Teachers in Ireland were somewhat less supportive of constructivist beliefs, and somewhat more supportive of direct transmission beliefs than their counterparts in all five comparison countries' (Shiel, Perkins, & Gilleece, 2009, p. 6). Without an official policy in place it is difficult to see the majority of teachers engaging in any meaningful way with the available digital resources. In the last 10 years schools have greater access to interactive whiteboards, data projectors, tablets, e-readers, mobile phones and digital cameras than ever before. There is also some level of limited technical support in place. Ireland needs a policy on how schools can embrace OERs and exploit the available resources to their full extent. The Department of Education's position is that:

'The Department's Inspectorate, in its work with schools, promotes active learning approaches rather than over-reliance on textbooks and workbooks. The Department has issued Guidelines for Developing Textbook Rental Schemes in Schools and these outline a number of strategies to avoid the need for workbooks or to allow workbooks to be reused from year to year. Scoilnet.ie is the Department's Official education portal. It contains curriculum relevant digital resources and supports for use by teachers. The site is being redeveloped in 2013 and will support the inclusion and sharing of learning objects. The website will become a repository of Open Educational Resources (OER) where the assets and resources developed by teachers, former support services and others involved in education can be centrally collated and found. The site currently has approximately 13,000 existing resources. The Department provides funding towards the provision of ICT equipment for both Primary and Post Primary schools where an extension/refurbishment project or a new school building is being provided. For Primary Schools the allocation is €5000 per mainstream classroom. For Post Primary Schools the amount of funding for ICT equipment is calculated based on the Schedule of Accommodation and the subjects being taught in the school'.

Historically funding for hardware has been prioritised over funding for software. This is now less of an issue with grants, etc. available. One of the main challenges now is recognising how a digital divide can manifest and how to prevent it at a grass-roots level. The digital divide is caused by several issues including age of the machine; connectivity; online skills; independence and freedom of access and computer-use support (Marcus-Quinn & McGarr, 2013). The definition of digital divide must therefore include all of these issues. The divide that can be observed at second level also includes the kind of use of the available technology as indicated by Mulkeen (2002) where a school advocates some use of the available technologies but in a very shallow way, in comparison with a school ICT policy that advocates and supports a considered approach to the integration of technology into the teaching and learning experience. The challenge for schools has therefore shifted. In 2014, access to the hardware is less of an issue. Now the challenge is to cultivate a classroom environment which takes advantage of open digital teaching materials. Teacher s must be given the necessary training to enable them to search for appropriate curriculum-specific materials that they can either use 'out of the box' or that they will be able to tailor in some way to best fit with their own teaching methodologies.

One of the best ways to limit the digital divide in the classroom is to introduce teachers to the benefits of using OERs created by teachers for teachers. There are pockets of good practice but it is not widespread. If teachers started to use the repositories more, if they played an active part in the communities of practice they would in turn be able to help shape how the repository defines and searches to best meet their needs and they may also be able to influence how the resources themselves are offered.

Hamilton (2013) sees that the way towards progress is accountability. He argues that the dominant reaction to such accountability measures is primarily one of fear. However, we must institute some kind of accountability and policy if any real change is to occur. Hamilton cites the accountability measures, such as No Child Left Behind (NCLB) legislation in the USA as an example of this. Such measures are a result of an educational system failing too many students.

Ireland should be participating to a greater degree in schemes in the EU and beyond. How do our international neighbours Holland and Finland perform? They seem to be engaging with and availing of national and international projects to a much greater degree. Many of these countries have a national policy in place. Teachers are encouraged to engage in meaningful activities and use resources that develop the important digital literacies amongst students. OERs can play an important role in addressing this as they can be tailored to meet the needs of specific students and curricula (UNESCO, 2012). So where could Irish teachers look for such resources?

The Directory of Open Access Repositories opendoar.org provides a complete list of the world's repositories (currently over 2100 of them), while the Registry of Open Access Repositories http://roar.eprints.org/information.html lists the repositories that are open. The aim of ROAR is to promote the development of open access by providing timely information about the growth and status of repositories throughout the world. Open access to research maximises research access and thereby also research impact, making research more productive and effective:

- Carnegie Mellon Open Learning Initiative
- Connexions
- Khan Academy
- JISC Content
- JISC Open
- Leeds MET OER repository
- MERLOT
- MIT Open Courseware
- Open Spires
- Open Discovery Space
- Oxford Podcasts
- Open University on YouTube
- Open University on iTunesU
- U Now
- CAREO, Wins-Online
- Orange Grove Repository
- Khan Academy
- BrainPOP
- Teaching Online Pedagogical Repository

One example of a successful digital resources project is the Open Discovery Space (ODS) project (Richter et al., 2013). The ODS project is assisting schools progress from the early stage of ICT and eLearning integration in teaching and learning to becoming what is termed an eMature school. On the 9th of May 2014 Finland welcomed their 100th pilot school engaged in the ODS/ISE projects—a small 74-student primary school in Porvoo, about 50 km from Helsinki. The ODS now has more than 700 affiliated schools, to involve and engage even more schools Europe-wide. ODS offers a platform that is designed for practitioners. The ODS position on affiliated partnerships is that they provide an opportunity to get in direct contact with the community, involve the future users into the development at an early point of time and receive feedback and recommendations for improvement. The partnership as an ODS-Affiliated Partner can include many advantages for practitioners, schools, policy makers as well as network and media partners, such as

- Receiving first-hand information on the project's progress and novelties
- Being informed about upcoming events, such as conferences, webinars and summer schools
- Getting access to development versions of the ODS platform
- Having access to and participate in the ODS pilot trials
- Receiving support directly from the ODS consortium team
- Influencing the development of the platform, its features and tools by communicating individual requirements and providing feedback
- Discussing own experiences and challenges with other ODS-Affiliated Partners and the ODS consortium team
- Multiplying own dissemination channels
- Having the opportunity to share learning repositories and educational resources
- Massively enhancing the own learning repository's customer base

For the diverse purposes of potential affiliated partners, ODS offers different types of affiliated partnerships, for which there is no charge. However, while every ODS Community Partner simply can self-register for the partnership, for some types of partnerships, agreements that particularly adjust issues like intellectual property rights and/or obligations are strongly to be recommended. For entering any type of affiliated partnership, the ODS generally recommends to start registering as an ODS Community Partner and 'upgrade' from this point. However, it is possible to directly contact the ODS consortium. This ODS model is progressive and is one which should be adapted to similar services.

Conclusion

This chapter has highlighted the availability of digital high-quality teaching materials in international Open Educational Repositories. Since 2009 many departments within third-level institutions have successfully developed and/or repurposed digital learning objects which they have uploaded to a central repository where these learning objects may be shared with colleagues at other institutions and may be reused or redeveloped (Pegler, 2012; Wiley, 2010; Yuen, Chow, Cheung, Li, & Tsang, 2012). A very small number of second-level schools have also recognised the potential of collaboratively developed material and have developed similar repositories to share learning resources amongst staff and students (Driesche van den, 2011). Irish schools have largely overcome the initial barriers that hinder the integration of ICT in schools (Marcus-Quinn & McGarr, 2013). However, there is a long way to go before every classroom sees students availing of the technology to transform their learning. The reform of the Junior Cycle sees the burden of creating short course for students put on teachers. Schools should look at this as an opportunity to look at what is there, to identify resources from the many internationally funded OERs. They should look to repurpose what they can and integrate these digital teaching materials into their own classroom to enhance the teaching and learning environment. As Hamilton (2013) advocates we must encourage an evolving, personalised digital learning environment in which all stakeholders including policy-makers, administrators, teachers and students collaborate to create a future of renegotiated core competencies. However, it is unlikely that this will happen without a national policy advocating the use of OERs in place.

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Chapter 29
Teacher Awarenesses and Blended Instruction Practices: Interview Research with K-12 Teachers

Anne Heintz, Michelle Schira Hagerman, Liz Owens Boltz, and Leigh Graves Wolf

Abstract In our research, we talked to four early-career teachers who have adopted blended instruction practices for their classrooms. Through systems-based thinking that held in view awareness of self, learners, context, pedagogy, and interaction, these teachers established a blended classroom driven by a consistent vision and manifested through complex and diverse means.

Keywords Online • Blended • Hybrid • K-12 • Elementary • Middle school • High school • Systems thinking • Awarenesses • Interview • Urban • Rural • Pedagogy • Blended instruction practices • Classrooms • Teachers • Blended classroom environments • Systems-based thinking • Awareness of self • Students • Content • Interaction • Discussions • Teachers • Innovate • Educational goals

Introduction

Since 2010, we have designed, revised, and taught a graduate-level online course called *Teaching Students Online*. About 80 % of our students work in K-12 schools in the USA and around the world, and they are primarily interested in crafting *blended learning experiences*. Many of these teachers want to integrate the best of their face-to-face instructional methods with thoughtfully designed online experiences that could engage, expand, or extend learning (Bonk & Graham, 2006; Ferdig, Cavanagh, & Friedhoff, 2012; Pytash & O'Byrne, 2014; Watson, 2007).

The interest we've seen in our course aligns both with expectations for technology integration in K-12 classrooms as outlined by the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief State

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School, 2010) and with evidence that models of blended learning are, indeed, gaining momentum in K-12 schools (Barbour, 2013; Ferdig & Kennedy, 2014; Johnson, Adams Becker, Estrada, & Freeman, 2015, Powell et al., 2015). Given that blended instruction can take many different shapes and forms depending on context, and that no single model is proven "best" (Garrison & Kanuka, 2004; Powell et al., 2015; Pytash & O'Byrne, 2014), we wondered what we could learn from students in our course whose work seemed especially innovative in its design. We wondered if an analysis of these teachers' thinking might provide insights into the complexities of blended instruction that, by extension, could inform other teachers, teacher education faculty and policy makers who, like us, need guidance on promising methods, practices, and mindsets for K-12 blended instruction in diverse contexts.

Background

Kennedy and Archambault (2012) suggest that "the most positive aspects of traditional and online learning can be combined to provide the best educational experience possible for K-12 students" (p. 198). We ask, "What does this look like?"

Considerable work on blended learning has focused on the structures, timetabling and technologies that enable its implementation in systems of schooling (Christensen, Horn, & Staker, 2013; Staker & Horn, 2012; Powell et al., 2015). However, if the purpose of blended learning is to leverage the affordances of face-to-face and online modes to design the most advantageous learning experiences for each student, then we must examine the decision making processes and funds of knowledge from which teachers draw as they design a blended complement of learning experiences for their students.

Theoretical Perspective

On the basis of the extant literature on blended teaching (e.g., Comas-Quinn, 2011; Davis & Fill, 2007), we assume that masterful pedagogical decision making in blended contexts is both dynamic and systems-oriented (Richmond, 1993; Smith & Thelen, 2003; Thelen & Smith, 1994). Teachers' thinking must account for and adapt to the many and changing interactions at play among the factors that enable student learning. Further, we assume that teachers' awareness of these factors feeds back into their design thinking.

Vanessa Rodriguez and Michelle Fitzpatrick (2014) have extended dynamic systems theories to a model for the development of expert teaching (at large). Rodriguez and Fitzpatrick lay out three interconnected systems that are recognised by expert teachers: the student system, the teacher system, and the teacher–learner interaction.

Teachers are aware of the *student system*: Each teacher has a store of information about learners' brains and behaviors. This store may come from academic study and/or a history of interaction; it may be minimal or extensive. The teacher takes this understanding of learners' minds, as well as data she has about individual students and the learning group as a whole.

Teachers are aware of the *teacher system*: "In order to recognise the student as an individual, the expert teacher must also recognise him- or herself as an independent system affecting the student" (p. 71). In recognizing that his or her teacher system factors in crucial ways in their teaching, teachers self-examine the contexts and motivations at play for them in both their personal and educational lives.

And teachers are aware of the *teacher–learner interaction*: This interaction is the back-and-forth of the feedback system between teacher and learner, where each person senses what the other has communicated, processes it, then responds.

In an NPR Higher Ed Q & A session (Westervelt, 2014), Rodriguez defines the five key awarenesses that help a teacher in managing the interplay of these three systems:

- Awareness of self as teacher: Consider how your culture, your personality, your family history and your values—just the things you find important—come to bear on teaching.
- Awareness of context: Target external factors such as state mandates, or the culture of the environment you're in and its history.
- Awareness of learner: Understand who your learner is as an individual.
- Awareness of teaching practice: Know your content and requisite skills such as lesson planning, time management and curriculum development.
- Awareness of interaction: Acknowledge you are interacting with a learner. Types of interacting include connection, collaboration, mutual effects, and synergy.

This model frames our research in instructive ways:

First, it is a model of teaching at large; it is not specific to online teaching. K-12 blended teachers are not exclusively online teachers. In a number of years, distinctions like "blended" or "hybrid" may go by the wayside, as K-12 teaching, at large, will take place in traditional and online spaces.

Second, as blended teachers, our teachers are working across learning spaces and interacting with their students in multiple modes. If our teachers are to come to rich understandings of their practice, competence, and areas for improvement, then a model that fails to position their work within a series of systems will be insufficient. We assert that thinking about teaching in terms of awarenesses is fundamental to the practice of blended teachers because, as other studies have shown (Comas-Quinn, 2011; Davis & Fill, 2007), blended teaching demands a negotiation of self and of one's teaching practice in an online space. Blended teaching requires awareness of context, and how that context supports, ignores, or even discourages teaching in online spaces. Blended teaching requires awareness not only of learners and interactions with them, but of how online spaces change perceptions of learners: how interactions with students can be made and used for formative feedback across all spaces. We argue that one cannot design and work in an effective online space for learning without calling upon these five awarenesses.

Additionally, this model supports our methodology: it puts teacher awareness at the center of the enterprise of teaching. It becomes incumbent upon us then to discern teachers' awarenesses to better understand expert teaching.

Research Questions

Our inquiry was therefore driven by two research questions that permitted the exploration of teachers' decision making and awarenesses.

1. How do teachers who have designed innovative blended learning experiences, and have taught in blended learning environments, talk about their work?
2. How could these teacher reflections inform other teachers interested in blended teaching and learning?

Method

To explore teachers' reflections on their blended teaching experiences, we conducted semi-structured one-on-one interviews with each participant over Skype or Google Hangout in 2014. Our interview protocol may be viewed here, or visit http://bit.ly/1V4pwmH. Interviews were recorded (video and audio) and then transcribed for analysis of themes. We analyzed the data using methods of grounded theory (Charmaz & Henwood, 2009; Glaser & Strauss, 1967). From the data, we constructed a set of initial codes and applied them to all transcripts. To refine the coding manual, we examined our individual application of codes, negotiated differences of interpretation, and strengthened our definitions. Anne recoded one transcript as an exemplar for the coding of all other transcripts. Liz used the exemplar and the coding manual to analyze all four interview transcripts. Liz randomly selected 20 % of the content assigned to each code for an inter-rater agreement test with Michelle. This resulted in a total of 72 excerpts. Percent agreement across all seven codes was 75 %. The result of the kappa analysis, $k=0.619$ [$se_k=0.070$] indicated that the strength of our overall agreement, though not as high as we might have liked, was acceptable given the integrated nature of the ideas often expressed by the teachers. All disagreements were negotiated and resolved.

Next, we applied the definitions of Rodriguez's & Fitzpatrick's (2014) teacher awarenesses to our data. Please see Appendix for an infographic of the coding scheme.

Finally, we shared our analyses with participants and invited their critical responses to our interpretation of their thinking. We integrated feedback so that the interpretations of the data were consistent with our interpretation of the teachers' thinking, and also consistent with participants' own understandings of what they meant.

Participants

Participants were early-career 4th to 12th grade teachers who were purposefully selected on the basis of the work they did in a course we teach in the Master's in Educational Technology program at a large research-intensive university in the

Midwestern USA. The course, *Teaching Online*, walks students through the process of creating online content for their classrooms. The expectations of the major course assignment are that teachers develop an online unit, complete with its own student learning objectives, teacher and student activities, and assessments.

The participants in this study demonstrated an innovative, especially creative, or unique approach to this work. All participants went on to implement in their own classrooms the blended learning they had designed. Our teachers work in urban and rural districts, across grade levels and content areas.

Meet the Teachers

Table 29.1 presents data about the teachers which was current at the time of the interview: 2014.

Findings

We present what we learned about how teachers talk about their blended practice through the Five Awarenesses lens, according to our data analysis coding procedures.

Awareness of Self

Across the board: For all four teachers, their identity—their sense of a unique self—played a large part in their teaching. We heard that "who I am" is essential to "how I teach." We also heard that a sense of self as a teacher was influenced by what they thought student perceptions of them were or what they wanted student perceptions of them to be.

Individually: Here, we present representative samples of how teachers talked about themselves with us.

Table 29.1 Demographic data of participants

Teacher	Years as a teacher	Grade/subject for blended course	City
Allison	3	6th grade Science	Orlando, FL
Destiny	2	9th grade English	Detroit, MI
Emily	3	4th grade Music	Lakeview, MI
Jeff	6	7th grade Social Studies	Wayne, MI

Allison

Allison comes from a tradition of teachers in her family.

> It's funny I joke with my mom who's actually sitting in the room over here, listening to us, and she's also a teacher, we talk about how Mrs. [Allison] is sometimes very different than, you know, Allison. So I think a lot of teaching is kind of putting on a show, and if that's how I'm able to reach the kids and get them excited about science and have them more engaged then, you know, I'll do that; it's fun.

Allison describes how her teacher self can be a differing version of who she is: something she puts on for pedagogical effect and for her own and student enjoyment.

Destiny

Destiny identified how her students extend a role to her beyond that of teacher:

> None of my kids call me Mrs. [Destiny]. The only kids that call me Mrs. [Destiny] are the new kids–all the kids that have had me before call me Momma. So during the day I literally hear, "Ma, Ma, Ma, Ma" all day. So, you know, I don't know what I would be without that. I don't know who I would be without that.

Destiny describes how providing social and emotional support for her student population has come to contribute to her sense of self.

Emily

Emily wants her students to know about the things she loves:

> I take what I do outside the classroom, and I bring it in and share it with my students and use that to help them understand music. I'm not afraid to let my students know what I do outside of school, who I am, and what my family is like. I know there are a lot of teachers who have a strict separation, but I don't mind letting them into my world a little bit.

For Emily, this revelation of self to students is a way to connect; and connecting with others is also, she believes, a core component of her content area of music.

Jeff

Jeff describes himself as a person who has always been interested in anything technological and as having a quick mind:

> I am a person who is outrageously… I think a whole lot. Almost to the point where I drive myself crazy thinking things up, but I also have a really dry sense of humor.

In talking about his teaching and design work, Jeff characterises himself as one who likes to try to create the most ideal conditions: conditions that are fertile for "serendipity" in learning. He characterises himself as a Captain Ahab—pursuing a seemingly elusive target—but believes the chase is worth the effort.

Awareness of Context

Across the board: Context for teaching influenced teachers' motivation to teach online, as well as how teachers went about the process of designing and teaching online content.

Individually: We present representative samples of how teachers talked about context and motivation to teach online.

Allison

Allison attributes her decision to try blended learning to a dissatisfaction with spending so much time on getting across basic skills in class. She wanted to move some of this type of instruction to out-of-class time in order to focus on higher-order thinking during F2F time. Also, her school had recently implemented a 1:1 laptop program. Her network of teachers within her family introduced her to flipped learning (a type of blended learning).

> I first heard about flipped learning from my aunt who—I live down in Florida—she's up in Grand Rapids, Michigan. And I had no idea what flipped learning was so I had to Google it. And kind of figure out by watching some Youtube videos and what not.

Allison wondered if her middle school population would be ready for flipped learning, but she read Bergmann and Sams (2012) book and was motivated to try. Allison's context for teaching included her family, her own research and reading, and, of course, her school. She was the first in her school to try flipped learning, working in a school context that was eager to, yet unfamiliar with how to, support her in her project.

Destiny

Destiny taught in a school in Detroit that used a schoolwide digital learning platform. It was this element of her context that most compellingly influenced her design of blended teaching practices. Destiny says of the platform:

> All I have to do is teach someone how to log on, and if you get stuck, I'm there to help you. So for me it was something that I didn't want to use because one of my biggest things that I'm known for as a teacher is my ability to build a relationship with the kids. If I stick with [the platform], then that takes all of that away from me.

Destiny's objection to the platform was not only ideological but practical. She says:

> The first year I really tried to use [it], wholeheartedly, I was like, ok, I'm going to do this. So then every time I would log in, it wouldn't work; kids couldn't see the right stuff, and so then after like a month of trying this consistently, I got tired of looking like an idiot in front of my kids. I get to school, we log in and nothing works, so then I quit.

Destiny accepted the lower score on a performance evaluation that came with not using the platform. As the school's go-to technological support person, Destiny had knowledge of educational technology and was motivated to work in a blended learning space of her own design: one designed with her talents and her students in mind.

Emily

Emily is a music teacher who sees students in six different grades once a week; she has over 700 students. Part of her motivation to teach online was to increase the spaces for contact with her students. But blended learning as an option for this may not have crossed her mind were it not for her academic context. She says:

> I had never considered it [blended teaching] until I took CEP 820 [our course]. So the entire idea of teaching in an online space came from that course.

Before taking the course (which requires students to develop, but not to teach, online content) Emily had put materials for her class in an online space, but really only for reference for students who had had to miss class. She had little experience in designing a unit in which her face-to-face teaching would be only part of the curriculum, but this online space would contain other key components of the teaching and learning going on. Emily created a unit from scratch in Haiku.com. She had created it to fulfill the requirement of her graduate class and wanted to try it to improve the organization and delivery methods for her unit, and she had online-specific curriculum (a series of interview videos she had taken at a local Jazz Festival) that she wanted to share.

As a fourth grade teacher, Emily knew her blended learning experience would be one she wanted to deliver entirely at school, not knowing the extent to which her students and parents would be able to work online at home.

Jeff

While always interested in anything technological, Jeff's interest in blended learning—to taking technology use beyond simple supplement—to chasing that white whale—was largely due to his master's study in which both research and the community of learners were integral.

> My Master's is the foundation of everything that I do in an online space. Before I started learning some of the research and plugging into a community of likeminded educators, it was—my technology use—was really peripheral. Somewhere along the line in that program, I became more interested in the designing, planning and creation of holistic online environments—more so, than simple technology supplement stuff.

Jeff's context was a supportive school environment in a high poverty school. He says of his context:

> I was able to get free reign from my administrators in my buildings, and I'm really appreciative of the fact that they didn't always completely understand what I was doing, but they put me in a position to succeed and try things. And I appreciate the librarians for letting me steal netbook carts and—everything that goes along with that really helped me to find myself in learning.

Jeff felt supported in his early blended learning efforts by his administrators and felt appreciation for a freedom to explore.

Awareness of Learner

Across the board: Teachers are tuned in to the entire learner system: that is, what makes up their students' lives, communities, and discourse practices. Along with academic performance, these elements inform teachers' understandings of their learners and influence their design and pedagogical work.

Individually: We present representative samples of how teachers talked about student practices.

Allison

Allison knew what her students were going through in terms of emotional changeability and grade-to-grade transitioning. She kept this in mind as she worked on her blended unit.

> I work with 6th graders so it's like, it's so interesting, like one day they hate you and one day they love you, and it's such an interesting year with adolescents, so I think just kind of creating that supportive presence and excitement for science it's like something I almost had to do to reach them, those students.
>
> When I started flipping my class I started testing it out and making a video, and when I rewatched the video that I made I was like, "Oh my goodness this is so boring, I don't even want to watch it." Let alone would my students, my 6th graders, ever want to watch this. So I kind of had to realise even though I was recording to an empty room and I was like talking to no one, I still needed to be animated.

Allison was keenly tuned into the needs and expectations of her 6th grade population.

Destiny

Destiny knew she had a range of abilities in her class:

> I get this vast majority of children who have these gaps that I have to try to navigate. So for me: because I can put a Flocabulary video on Weebly; we can do assignments and talk about it; it's something I think that can kind of help me assess a multitude of learners. I may very well in one class have a kid that is cognitively impaired, and their ability is 1st grade. But they've got to do this assessment; I've got to get them prepared. I may have someone who's in the 9th grade that tests at a 10th or 11th grade level, and so I've got to use a tool that hits kind of right in the middle, and that's what I wanted to create with this Weebly space.

Destiny selected particular teaching and technological tools in light of her awareness of the range of student abilities in her class.

Emily

Emily was aware of her fourth grade students and the novelty of online platforms to their learning. She had seen students active in online spaces and knew that given the opportunity, students would be delighted to use the discussion boards as an instant messenger with each other to discuss topics not related to the content. So she decided she was going to make very clear what was expected in discussion forums and what consequences would be for those who did not use them for class purposes.

Jeff

Jeff had a clear idea of what his students needed from him. He says:

> I dignified them as individual people who could make their own decisions to do what they wanted. For a lot of my students who didn't have fathers, they needed me to play that parental role.

He also knew that his students would get to know him best if he was simply being himself:

> You know, just because you throw Miley Cyrus in a lesson doesn't mean that students are going to learn the stuff they're supposed to learn. They're going to say Mr. [Jeff], knows who Miley Cyrus is.

Knowing his students' tastes, for Jeff, didn't mean an entire reorientation of teaching around those interests: he kept his eye on the pedagogical goals.

Awareness of Teaching Practice

Across the board: Teacher practice in a blended learning environment is where the various systems at play in the teachers' awarenesses are given shape. Teaching practices are where the rubber meets the road. All of our teachers found that pedagogical choices and actions in one learning space worked in tandem with the pedagogical choices and actions in the other learning space, and all of our teachers experienced self-reported growth in their range of practices due to implementing online teaching and learning.

Individually: Here we highlight one teaching practice for each teacher that is a particularly demonstrative example of how teacher awareness of systems at play influences pedagogical choices and actions.

Allison: Savvy Screencaster

Allison made excellent use of the blended learning technology of screencasting: recording what appears on a computer screen. This recording can be visual and auditory and can combine multiple screens into one as well as make use of design effects.

The way she crafted her screencasts took into account her knowledge of the self she wanted to display, her students' desire for a goofy, enthusiastic "Ms. Allison," and the content she needed them to have prepared for in-class lessons.

To record lectures, Allison used Camtasia software (Techsmith Corporation, 2015) to create a video of herself talking about her slides. Students saw her slides in the main frame, and then in the bottom right corner was the video of Allison talking about the slides. The program gathered into the students' field of vision what they would see in class: a talking teacher and slides on a screen, with the difference being that students could pause or rewind or fast forward as needed with the online lecture.

In her in-class lectures, Allison spoke in a robot voice as a note taking cue for her students: when she was giving a lecture and she wanted students to write something down in their notes, i.e., vocabulary, she would change her voice to speak like a robot. This is something she carried into the lecture videos she created for her online space. Allison also created "bloopers"—when she messed up in recording herself, she included these clips at the end of her instructional videos as a motivation tool for students to keep watching. In an end of the year survey, she found that students cited these bloopers as their favorite part of the online experience.

For shorter, more informal pieces of content, Allison took video of herself "out on the town." She would upload to the online space short video or pictures of her extracurricular trips, e.g., she recorded a lecture about prokaryotic and eukaryotic cells at Disneyworld. Then, at home, she supplemented the recording with graphics of the cells and little thought bubbles she herself created to exemplify what was said.

Mindful of the fact that many of her students didn't have the means to travel, she brought some of her science-y peregrinations into the classroom and connected them to relevant content.

Destiny: Community-Reinforcing Code Switcher

Destiny set out to create an online learning space which honored her teacher self and her students' learning needs, as well as their shared classroom community. Using Weebly (http://www.weebly.com), Destiny wove together linguistic styles that she and her students used. For example, she designed a radio button students would click to advance to the next screen with the text: "Press here; (You know you want to)." This type of "cheek" is not something students would have experienced in the content of the school-wide platform. Destiny talks about pedagogical priorities with regard to her awareness of a shared use of African American Vernacular English (AAVE) underlying this light-heartedness in tone:

> Even though I teach English and I want my kids to master Standard English, I'm very well aware of how we interact as African Americans with Black English—it's very important to who we are. I'm very-I'm known for code-switching, so I can go from being very, very standard to being very kind of urban, and I code switch when I teach. You want to do that; you want kids to be able to switch things up, because I probably would.

Because the school-wide platform was so unpopular, Destiny worried that her students would not appreciate how an online setting could contribute in *positive* ways to their learning. Destiny used Twitter and Instagram and shared these accounts with her students. She put her handles for these accounts on the Contact Page of her Weebly unit. Destiny's students used technology to communicate with her about their social lives. Destiny wanted to open her students' eyes to the ways they could all communicate around English language arts content using technologies as well, and use them in the way they were accustomed to—as active participants. Through making use of class photos, discussion forums, and other community-reinforcing tools, Destiny provided a window into a kind of online learning that was more in sync with students' daily technological practices and social milieu.

Emily: Visionary Vocaliser

As a fourth grade teacher new to blended teaching, Emily sought to make her learning space as developmentally appropriate as possible. With over 100 students, she also needed to design for a comprehensive range of literacy abilities. Emily decided to record herself reading the textual directions for one section of her unit. Then, after observing students using the headphones in the lab to listen, she realised it would be helpful to record herself reading all the text. Many students read and listened along; many students only listened. Given her subject matter of music, through which connection-making is brought about through listening, and a desire to make a connection with students, it was important to Emily that it be her voice and not a text-reader available from the Web.

Jeff: Charting the Course with Chat

As a teacher in an urban school with large class sizes, Jeff incorporated a synchronous chat space into his online class. He appreciated being able to address student questions as they arose, often when both the students and Jeff were working at night. He says:

> What I really got drawn to after a while was how it [the online platform] stretched time and space out to where you could be as thoughtful as you wanted, and it put students on an even plane. Like if a student spent five minutes constructing something, it was just as good as someone spending 20 or 25 minutes constructing a response because in the end, all that mattered was the quality of the response at that point, so it factored it out.
>
> Something that gave me deep satisfaction was being able to extend learning—like I really enjoyed being able to respond to students' questions at off hours. I think I got to know my students a lot more.

He found that, in typed dialogue, he and students were able to deepen their understanding of the content and spin out ideas in a way that a student may not really have the opportunity to do until sitting with a professor during office hours at the college level (as much as that ever happens anymore). Dewey (1916) wrote that teachers desire to bring their minds into close quarters with their students'. The extra time and shared space that the online environment opened up facilitated this mind meeting for Jeff and his students.

Awareness of Interaction

Across the board: Our teachers took note of the pedagogically planned teacher–student interactions and solicited targeted-feedback interactions so as to improve their teaching practice and subsequent teacher–student interactions.

Individually: We present representative samples of how teachers talked about interactions and subsequent revisions.

Allison

Allison's science class included a lab component. As a part of her curriculum before teaching in a hybrid manner, she included an assignment where students could create their own lab around a question and topic that interested them. Before she made the unit a blended unit, Allison's students turned in their plan for their lab and she graded it, and that was as far as the assignment went. But because the blended space freed up time in the F2F class, in her words, she needed to "get creative on how to fill it." One of the possibilities now was for each student to not only plan, but to carry out in class, the lab she had designed. Her revision of practice was a result of both her students' improved grasp of basic skills due to the ability to re-watch and move through content at their own pace and the extra time she had in class. She hadn't planned for students to carry out the "create your own lab" assignment when starting to teach in a blended learning fashion, but her attention to the interaction during blended teaching pushed her to extend her practice.

Destiny

Destiny took notice of what her kids appreciated about her online space:

> A big picture was on the front—it was a picture of me and some of my kids—they loved that because they felt like, "Oh hey, we were a part of this, I remember this day." They also enjoyed the fact that there was a discussion forum and they could talk back and forth to each other, and I'd pull that page up, and we'd talk about the comments that kids were making. They liked that they could click on a picture and something would happen. They just liked the way it looked and felt because it felt like a webpage, something you would interact with, you know, just in your free time.

She also asked targeted questions of her students about the online space in an effort to improve it. She says:

> I ask them a lot—like if I give them something—I ask them, "Do you like this?" Some days I spend time where all we do is talk to each other, and I ask them about certain lessons that I taught or the way that I taught something. And if they liked it or not, and if they didn't, we talk about why, and if they did, we talk about why they thought that was beneficial, why it helped them learn.

Destiny's revision practices were rooted in feedback from her students regarding their experience.

Emily

Emily was engaging in revision-oriented interactions and paying attention to the results of these interactions before she even began teaching the unit. She says:

> I got some teachers' children who stay after school anyway, and I had them come into the lab, and I just kind of watched over the shoulder as they were, you know, navigating through the course and that saved me so many headaches. I couldn't imagine having to fix all the things I fixed with those three kids with 30 kids in the classroom.

And, like Allison, Emily taught a unit she had taught previously in a F2F-only mode. Also like Allison, Emily was able to change the final assessment. In previous semesters, at the end of the Jazz unit, she had students stand up and present their bio on their jazz musician to the class. This was what she had planned starting the unit. But because Emily knew from data collected in the Haiku platform which student was researching which jazz artist earlier in the process, she was able to arrange ”popcorn meetings” where students presented their artist in small groups in the F2F classroom. In this configuration, students conversed with each other and compared and contrasted their artists. Emily also found the information each student had on their jazz artist was more complete than she'd seen in previous years due to the online resources she had been able to point them toward to use in class.

Jeff

Jeff revised his blended space throughout the day. Based on his F2F observations early in the day, he made quick changes to the online platform for the benefit of students he taught later in the day. He says:

> I would take feedback in that face-to-face environment, and their difficulty, and go in and redesign certain aspects of the online stuff, so that by the time we got to 5th, 6th, 7th hour, kids were rolling through no problem. And there's no difference between that and the completely face-to-face thing.

Jeff identified that his revision practices for his blended space come from feedback from students.

Discussion

If we trace a thruline from awareness to awareness for each teacher, we see rich stories emerge.

Allison: A teacher from her roots, Allison desired more opportunities to challenge herself and her students. Mindful of her strengths and student needs, Allison used blended learning tools to arrive at those spaces for learning where she could engage students in higher-order thinking through the friendly portals of goofiness and consistent structuring.

Destiny: Pushing against a system that did not work for her or her students, Destiny created online learning spaces that honored who she and her students were and the relationships they had formed.

Emily: A teacher new to blended learning who was teaching students about not only music content but how to do blended learning, Emily used student feedback at every step to make their first foray into the experience one that was informed and mindful of the range of abilities across a large group of over 100 students.

Jeff: A teacher who strives for pie-in-the-sky instruction while maintaining a realist stance about learners, Jeff used many different online tools in a spirit of perpetual revision to open up spaces for edifying conversation where he and students could quiet the din of the 35-person classroom.

Our study is a very limited contribution to understanding blended learning. We did no classroom observations, collected no data from students, nor did we collect or measure performance criteria. We listened to teachers talk about their practices and the awarenesses they have which influence their choices and actions.

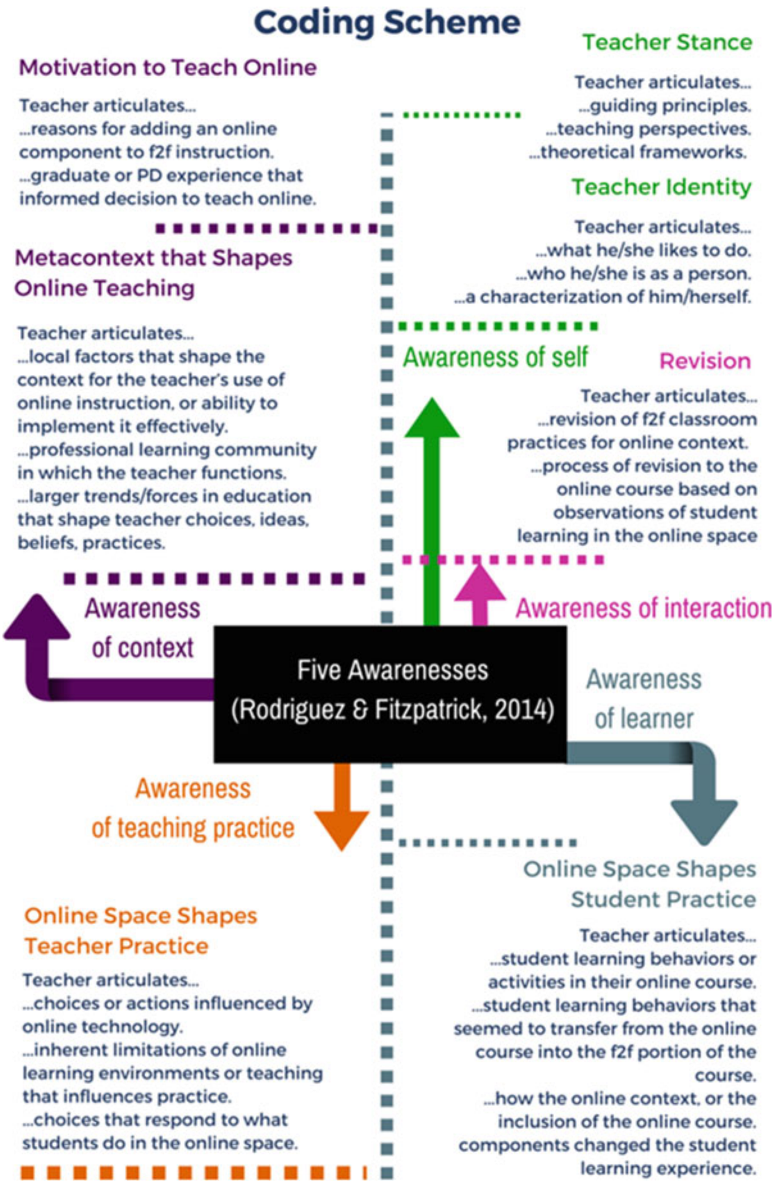
Through these interviews, we found that teachers' sense of self, of their students, and of teacher–learner interactions served as dynamic and interrelated factors that shaped their practice. The online environment provided a space in which these teachers could connect with students, rearticulate their individual teaching self and their priorities, and engage in a cycle of revision and reflection in a manner consistent with the development of expert teaching.

From this research, we feel we can suggest the following to blended teachers: Make an inventory of your five awarenesses: self, context, learners, teaching practices, and interaction. A tool for this evaluation can be found in Rodriguez and Fitzpatrick (2014). Ask, as we did: What are your motivations for blended teaching, as influenced by context? What are the revisions you can make to your blended teaching, in light of your teacher–student interactions? Paying close attention to the dynamic, interconnected systems that are at play in the blended learning environment will move your blended teaching toward expert teaching.

This targeted inventory of awarenesses will facilitate practitioners in steering the course of their blended instruction. The initial impetus to teach in a blended manner may have come from one of these awarenesses in ascendancy over the others—e.g., context, because an administration has asked that all teachers try Google tools; or self, because a teacher is feeling stuck and wants to challenge herself professionally; or teaching practices, because a teacher has access to a pedagogy facilitated by a technological tool and wants to experiment with this new method. However, targeting *each* of these awarenesses will help to ensure that no particular awareness holds ascendency *in practice*. This stance may mitigate the risk of following an original impetus for blended teaching while ignoring effects on the other systems at play—e.g., satisfying the administration while frustrating students; reaching professional goals with practices that don't meet student needs; or introducing an exciting new technology without incorporating a strategy to improve and revise its use based on student feedback.

Blended teachers work within *dynamic systems*. And the teacher brain is the dynamo at the center of the enterprise. We feel privileged to have talked and listened to four pioneers in the relatively new frontier of blended education. We hope that by demonstrating their drive to innovate and their various techniques for doing so, we provide other blended teachers with an example of practice that is centered around and within the teacher's awarenesses, and is thus a rich enterprise: driven by a consistent vision and manifested in a complex and diverse manner.

Appendix



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Chapter 30
Professional Communities of Practice: We Need Them, But How to Develop Them Successfully?

Wouter Vollenbroek, Joachim Wetterling, and Sjoerd de Vries

Abstract The Dutch education system is in a gradual transformation from standardised curriculum driven education to personalised education. Drivers are new media developments, future job transformations, recognizing the relevance of 21st century skills, and more. Dutch teachers increasingly acknowledge the continuous need for professional development, innovativeness, and continuous development of education in general. Therefore teachers and policy-makers increasingly unite in professional communities of practice (PCoP) in which the individual development and the development of the community is leading. In the PCoP, a group of educators meet each other on a regular basis to share expertise, and work collaboratively to improve teaching skills and the performance of students. In Education21 (Onderwijs21), a Dutch PCoP-initiative initiated to improve K-12-education, teachers and policy-makers from K-12-schools in the Northern and Eastern region of the Netherlands develop in a co-creation context the education of the twenty-first century. The network behind Education21 consists of primary schools, secondary schools, teacher education institutes, and education professionals, who recognise the importance of continuous professional development. The main goal of this PCoP is to contribute significantly to the success of the foreseen transformations. The first experiences in the PCoP show that participants acquire knowledge relevant to the transformation in their schools, by using an action-based research approach in a community-oriented environment. In this chapter we describe our approach, we give examples, and conduct a SWOT-analysis to identify the strengths, weaknesses, opportunities and threads of this approach. This results in a practical resource and method for regions to successfully develop a PCoP in a K-12-context.

Keywords Professional Communities of practice • Reflective spaces • Dutch education system • Standardised curriculum • Personalised education • Teachers Professional development • Innovation • Learning needs • 21st century skills • Education21 • Education stakeholders • Schools • Primary schools • Secondary schools • Teacher education institutes • Education professionals

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Introduction

The majority of students are educated for jobs that will no longer exist in 10–20 years, or in another capacity than is currently the case. Studies of Levy and Murnane (2012) and Autor and Price (2013) confirm this trend and show that the occupations focused on predominantly moderate routine activities and manual nonroutine activities will in all probability disappear. Declining portions of the labor force are engaged in jobs that consist primarily on routine cognitive work and routine manual labor—the types of tasks that are easiest to program computers to do. Growing proportions of the nation's labor force are engaged in jobs that emphasise the expert thinking or complex communications—tasks that (currently) cannot be done by computers. These knowledge and skills are operationalised in the twenty-first century skills. A skilled teacher is an expert in complex communication, able to improvise answers and facilitate dialogue in the unpredictable, chaotic flow of classroom discussion (Dede, 2010). Dutch educators and policy makers are aware of the fact that the twenty-first century skills are important in order to best equip students for the labor market of the twenty-first century. These are generic skills, knowledge, and attitudes needed to be able to function in, and contribute to the twenty-first century society. In order to prepare students properly for the rapid technological developments, it is important they become more skilled in dealing with ICT and acquire other more generic skills (for example: communication and problem solving, critical thinking, etc.) However, there is still a large gap between awareness and action. Dutch schools have to convert awareness into action and thus adapt education to the skills required for the twenty-first century. In this chapter, we describe our approach, give examples, and conduct a SWOT-analysis to identify the strengths, weaknesses, opportunities and threads to help others to effectively use this approach in other countries.

Our Approach: Education21

Goal

In this chapter, we describe the Education21-approach as the method to encourage action. The framework of the approach—followed by Education21—is derived from the learning organization theory. This theory assumes that an organization offers its employees the opportunity to develop themselves continuously and where the organization also transforms itself continuously (Pedler, Burgoyne, & Boydell, 1996). Slater and Narver (1995) define these learning organizations as organizations that continuously and proactively acquires, processes, and disseminates value-adding knowledge about markets, products, technologies, and business processes. It should be an organization that is able to constantly adapt to the changing requirements in society. A study of Reynolds, Sammons, Stoll, Barber, and Hillman (1996) recognise that the most effective schools are characterised as learning organizations. The effectiveness of these learning organisations and the resulting innovative behavior largely depends on the individual's work engagement (Isen, 2001). It is according to Jensen (2005) crucial to encourage employees to transform information into new knowledge and insights to stimulate the realization of engaged professionals.

Senge (2014) realises that learning in teams is a means to prevent employees for working in isolation where the individual's focus is purely on pursuing their personal goals. If a uniformly oriented team operates in the same direction, the yield will be much greater than by counting the value of individual's work. In a learning organization the teachers want to learn from and with each other. There is a mentality that there is always more that can be done to improve practices. The teachers collaboratively want to improve the education by following the vision of the school. However, Senge (2014) indicates that if an organization is willing to transform to a learning organization, it should stimulate learning and provide the opportunity to experiment, create and study own development issues. The learning organization concept encourages organizations to shift to a more interconnected way of thinking, where staff is stimulated in their training, development and initiatives in order to be constantly adapted to the changing environment.

Approach

Education21 is organised as a learning network, in which employees in different (learning) organizations related to education, collaborate with each other with the common goal to make education in accordance with the requirements of the twenty-first century. Education21 as a network initiates and supports the development of programs and projects on this topic. Initially, the learning network started as a Dutch equivalent of the Open Discovery Space network with eight primary and secondary schools, where educators from multiple nations collaborated with regard to the twenty-first century skills. In the last couple of years, the number of schools is rapidly increasing, with a network of approximately 60 schools and 600 teachers. Since the network is created in an open and transparent way, the network increasingly evolve towards a self-learning and self-organizing environment where participants create their own projects, programs and practices. Examples of these projects are:

- "Building on Ambition," program for learners and teachers to get insight in "future work"
- "The Learning (primary) School," program for teachers to develop "action research" to improve the educational quality
- Media Bureau North, program for the development of media and ICT-skills of teachers, learners and parents.

In our symposia and workshops we develop and share insights from these projects with each other.

Specifically, a learning network can be seen as an inspirational place for the members of the network where they can learn with and from each other and where they work together in collective learning processes (Wegerif, 1998). Goldstein and Butler (2010) refer to the Fire Learning Network as a network where multiple specific communities exist to jointly improve the firefighting. These learning networks create a joint exploration, by like-minded energy around a particular ambition or by conveying a specific theme together. This results in collaborative new insights, enrichment of each other's ideas, mutual inspiration, and practical problem solving (Arnell, 2014). Participation in a learning network is voluntary, but not optional. In case of Education21, educators are free to register themselves via de Education21 website to become a member of the learning network. The common understanding of the mutual expectations should ensure that individuals not only acquire knowledge, but also share knowledge. A learning network in itself mainly provide a shared identity (Dyer & Nobeoka, 2000); members belong to Education21. The thematic content of interactions between stakeholders are taking place within professional communities of practice (PCoPs). A community of practice is "a group of people who share a concern, a set of problems or a passion about a topic, and who deepen their knowledge and expertise by interacting on an ongoing basis" (Wenger, McDermott, & Snyder, 2002). In professional communities of practice, practitioners interact with each other on an ongoing basis in order to improve current practices, identify and create new products and innovations and share experiences and approaches. The Education21 network is characterised by a shared desire for quality development of (primary) education in the twenty-first century. The network has the intention of sharing knowledge as well as practical experiences to synchronise between goals of network partners and goals of the network.

Experience

Darling-Hammond, Wei, Andree, Richardson, and Orphanos (2009) appointed that professional communities of practice are most effective when teachers are involved in the educational decision-making process and have regular blocks of time to collaborate with each other. Creating these PCoPs is according to Darling-Hammond et al. (2009) a matter of creating a shared sense of intellectual purpose and a sense of collective responsibility for student learning. Moreover, the performance expectations and self-efficacy belief play essential roles in the knowledge-sharing behavior in the online environments (Tseng & Kuo, 2014). Siemsen, Roth, and Balasubramanian (2008) found evidence that the motivation, opportunity and ability of employees determine the willingness to share knowledge with their colleagues. These variables should not be addressed independently, but rather in a dynamic and coordinated way.

Lockhorst, Pol, and Admiraal (2008) acknowledge the necessity to create a sense of community. A sense of community triggers the development of social relations among teachers and this helps them to obtain potential resources and reliable support through their social network. In communal environments, educational stakeholders work better through the culture of trust and the shared responsibility. Besides that, employees feel more involved in order to work together to set goals. In the different professional communities of practice within Education21, the main objective is to trigger teachers to work on their own innovative power, creativity and learning capacity.

Further Development

The origin of Education21 comes from the desire to improve education that is continuously evolving, based on educational stakeholder interactions. It consists of a network with educators initiated by the educational stakeholders themselves. In living labs, during workshops, in masterclasses, and in online activities with students, teachers, and researchers—the members of the Education21-network—work collaboratively on school-related issues. Other professionals could register themselves through the Education21-website and during Education21-related events. The primary goal of Education21 is to develop education in the Eastern and Northern part of the Netherlands as a Learning Education Network, based on the learning organization paradigm. In other words, schools enhance their continuous capacity development both in terms of know-how (enhancing knowledge and skills) and action inquiry (sharing and processing information). The enhancement of the continuous capacity development of individuals mainly ensue in cooperation with organizations and associations within and outside the borders of their own school. Members collaborate with others to deepen substantive themes in this learning network. In order to acquire knowledge and skills schools increasingly search, not only for colleagues at other institutions, but also for expert advice beyond the district and even beyond traditional educational circles. The Education21 network is a learning education network in progress that is graphically represented in Fig. 30.1.

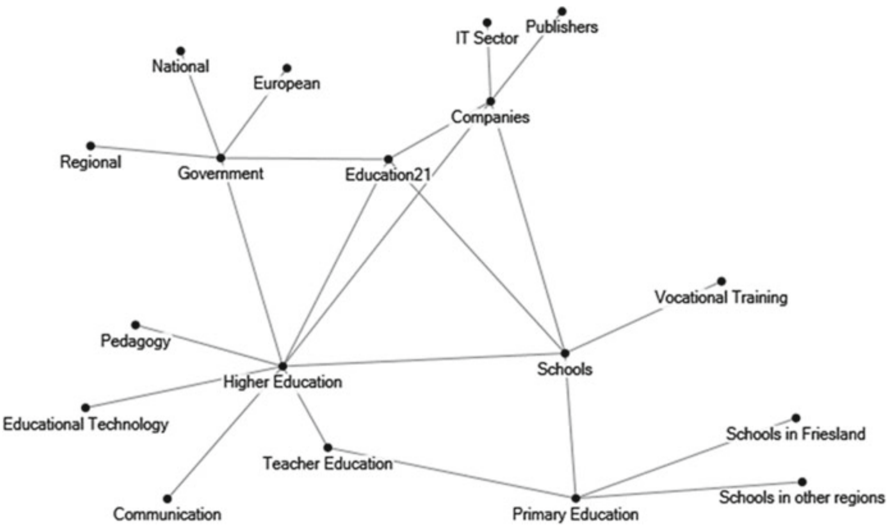

Fig. 30.1 Graphical representation of the current Education21 network

Lessons Learned

Learning networks such as Education21 can be a powerful element in innovating education at a regional level. Typical network members are professionals involved in educational practice such as teachers, teacher trainers, educational material developers and researchers in education. These professionals work in collaboration and individually on emerging and actual themes such as the adoption and implementation of educational technologies, robotics, social innovative behavior. How Education21 realises this in the Netherlands and what could be the impact on local and national level will be subject to research in the coming years. But at the moment—when looking at Education21 as a learning network in development—how can the network be characterised in internal as well as external perspective and what priorities can be administered to upcoming research? To do this, the network is analyzed using a method to identify the Strengths, Weaknesses, Opportunities and Threads (SWOT).

Strengths

One of the major strengths of the Education21 network is the clustering of schools and the potential and intention for collaboration among them. This intention is externalised by large participation initiatives at events such as workshops and conferences but also by positive feedback in conversation with representatives of schools in informal settings at these events. Elaborating on these strengths means facilitating and stimulating this collaboration from a central network coordination. This means that network members became active when this is stimulated and structured from a central network initiative such as by organizing a workshop, a conference but the challenge is to activate network members to keep the network active also in bilateral and small scale network dynamics.

The issue whether a network has a centralised coordination (one person or organization is responsible) or decentralised (all network partners are equally responsible for the network) is not yet investigated as a strong factor in professional CoPs. Also a strong issue in the network is the evident collaboration between schools and knowledge organizations such as research groups, developers of software and apps and educational publishers. Here, a major opportunity is also appearing in larger scale development of educational material ready for twenty-first century and in co-creation with the target groups. As research groups are involved a strong issue is the link between practical work in schools and scientific and practical research to develop knowledge concerning learning education.

Another strong point relates to the accessibility of the network. The network is open to any school or other organization that works on education in the context of twenty-first century skills. Because of the open network and the intention to innovate education at all levels, quality of education is expected to be enhanced by learning and developing schools and networks of schools.

Topic of research should be the process in which network partners decide whether to participate in a learning network, what effort they intend to invest and what value they can add to the network. The process of learning networks and the role in this process for aspects such as motivation, as well as opportunity and ability being with the network partners to add value to both network learning and their own learning process has been investigated by many for instance Senge (2014), Vaicaityte, De Vries, and Haitjema (2007).

Weaknesses

The weakness of the Education21 network is characterised by a low level of coordination within the network as well as internal and external communication. At this issue there is some room for improvement of network effectiveness and efficiency. Relatively much energy is required to realise small activity from network members.

Also the output of the network such as sharing of experience with other network members, initiating collaboration, publishing, etc. should be at a higher level both in qualitative and quantitative terms. A weakness that occurs frequently in network-based collaboration is the fluctuating effort network partners invest in CoP activity. Partners work hard and are motivated during events where they meet other network partners. Between these events and milestones network activity is getting less priority and if any activity is expected it should be initiated and facilitated by network coordinators. Coordinators are people from organizations central in the network and those with the highest intrinsic motivation to be active in the network. There is not a strong hierarchical structure in the Education21 network.

Opportunities

The opportunities as networked learning in the CoP Education21 is concerned is especially in how these networks can be organised, how they work and what effects they bring for partners but also for the network itself. The network creates a sense of community, a common ground, working at a common goal. This is considered a strong motivational factor. Also the network is based on a strong topic in the interest of today's society, the twenty-first century skills and how these can be integrated in education. This is a strong opportunity for the network to set ground in educational system and motivate for participation. The network has its origin in Friesland, a region in the north of the Netherlands. This region is faced with growing migration to other parts of the Netherlands. However, people living in this region are characterised by a strong sense of community, which can be considered an opportunity for networks such as Education21. For economic as well as demographic reasons the clustering of work in networks is considered a major issue for the region. Getting sustainable results where a high level of "ownership" in network partners is realised.

Threats

But there are also threats to success of the Education21 network. Focusing on twenty-first century skills in education is excellent but it should be avoided that this focus targets too much on technology and ICT solutions. Education21 should offer a broad platform for network partners interested in innovative and learning education in the 21st century but also make clear that there is more than media, ICT and technology. Further, the regional problems of the center region of the Education21 network are already mentioned as an opportunity, these can also become a threat, just as well as economic developments. In financial crises the amount of resources available for learning networks reduces so more energy is needed to achieve funding and funding could be less than making a reasonable working quality possible. Finally at a personal level, the feeling of autonomy of teachers can be a threat when teachers show a feeling of fear of sharing their examples of good practice or if teachers show a low level of willingness to use solutions developed by other teachers in the network. Exchange of knowledge and solutions among network partners because of the not-invented-here-syndrome or the fear that others will flourish on the energy they have invested to make something nice can become an obstacle to effective learning network functioning. Summarizing, most important threats to participation in a professional CoP are (1) people being too busy to do other tasks than those being primarily related to their job, (2) the growing amount of communities, networks and interest groups for professionals in the educational sector, (3) the low level of extrinsic motivation for participation in professional CoPs (no or very little resources or money), (4) fast changes in today's dynamic society leading to innovations worked on in CoP's becoming outdated before they are finished and (5) the decreasing relevance of professional CoP's at the management level leading to less willingness to allow their staff to participate. An overview of the strengths, weaknesses, opporunities and threats can be found in Fig. 30.2.

Strengths	**Weaknesses**
Collaboration potential Scale Schools- knowledge center connection Research platform Easy access to network	Coordination of the network Output Discontinuity
Opportunities	**Threats**
Common ground Motivation in network partners Trends in society Economic development	Focus on technology Regional problems Resources Teacher autonomy Lower management priority

Fig. 30.2 Overview of the SWOT-analysis

Conclusion and Recommendations

The first results of Education21 are promising—although there is also room for improvement—in this section we give some recommendations based on the method and on insights from the literature. Learning networks such as Education21 can be a strong instrument to collaboratively realise learning education and consequently improve twenty-first century skills in education. Based on the initial results, we recognise a great need for cooperation in education. Most educational institutions are struggling with the same issues and problems and a joint approach of tackling these issues and problems can provide more uniform, efficient, and effective solutions. However, it is not effortless to successfully create such a learning network and the underlying professional communities of practice. In Education21, we followed the subsequent eight phases to maintain, improve, and enhance the learning network: (1) development of a network plan which consisted of a network strategy and successive activities and events, (2) development of a core network of change agents in K-12-education, (3) development of a network of teachers, students, student-teachers, teacher training institutions, and professionals from the field, (4) creating and implementing the digital platform, (5) organizing the specific professional communities of practice based on personalised themes, (6) activating the communities by organizing blended activities, (7) organizing the network, and (8) activating the network.

In the next section we briefly describe some recommendations—partly based on lessons learned and partly based on theory—relevant for creating PCoPs in the context of education. These recommendations are partly categorised based on the featu Capobianco et al. (2006) define as valuable dimensions that could contribute to the development of a PCoPs among prospective engineering educators. These four dimensions are: (1) understanding the landscape of practice, (2) recognizing the challenges, (3) creating curricular resources, and (4) constructing new knowledge.

1. *Understanding the landscape of practice*

   Unidisciplinary collaboration limits the creativity, innovativeness, and practical orientation. It is more likely that members of PCoPs with a multidisciplinary background develop products, knowledge and approaches which are more out-of-the-box. People from different disciplines broaden each other's horizon and increase each other's theoretical and practical knowledge. In Education21, teachers, student-teachers, students, researchers, teacher training institutions, and professionals from the field were continuously involved into the development of the learning network and the underlying PCoPs. The primary objective was to mutually develop a common vision, which can be realised by involving all members in drawing up the targets of the PCoP. Mutual engagement ensures the support for these goals (Senge, 2014). A common vision depends on the extent to which participants in the PCoP understand the landscape of practice. If members of a PCoP cooperatively embrace a specific theme as essential to improve education according to the twenty-first century skills, than the success rate will also be increased.

2. *Recognizing the challenges*

   A learning network should consist of one or more community managers who organise the virtual and physical activities that stimulate interactions. Sonnenbichler (2010) mention the role of a community leader as the fourth step in his life cycle model. Participants first take on the role of visitor, after which they evolve to novice. In the next phase they become regular users and a few of these regular users then become a community leader (or manager), when the regular users are familiar with the history and inner workings of the community, they turn into elders. The community manager should provide the continuous impetus for the other members. Besides that, they should also outline and monitor the goals and objectives for the professional community of practice, and ensure that these goals and objectives are supported by the members. The continuity of the community in first instance largely depends on the activation of the community manager. This person challenges its members to actively create, develop, improve or share products, services, approaches, methods, and knowledge.
3. *Creating shared products and knowledge*

   Community building in knowledge driven environments is risky, many (potential) participants are afraid of losing power when sharing knowledge with unknown others (Wang & Noe, 2010). In order to tackle this issue, it is crucial to organise physical activities to build trust, commitment, and reciprocity among participants. An active knowledge agenda focusing on various specific themes ensures that participants meet each other in the virtual and the physical world. Some of these activities can be workshops, masterclasses, webinars, lectures, and conferences. This blended approach reinforces the likelihood of close cooperation between the members of the community. Based on our SWOT-analysis of the current Education21-approach we would suggest to create optimal synergy between online and offline activities. A physical activity should have an online value-adding follow-up and vice versa. The Open Discovery Space portal is an example of an online place where these value-adding activities could take place. It is a communal portal initiated to create, share and improve open educational resources, with peers. When members accept, respect and trust each other, the chance that knowledge and products are commonplace, will increase. In that case, a PCoP will consist of shared resources, routines, tools, and/or ways of doing things. Products and knowledge developed in and acquired from the PCoP must be publicly available for every member. Individuals within a PCoP
4. *Focus on individual learning to enhance team learning*

   Communal environments can be fruitless without the full participation and motivation of members. It is for that reason crucial that members in PCoPs are motivated to participate and share their knowledge and experiences. Four variables are important determinants for the level of participation: an individual's motivation, an individual's opportunity, an individual's ability, and the communalities within the PCoPs. Broadly speaking, motivation captures the reasons one participate, opportunity represents the environmental or contextual mechanisms that enable action, ability represents the individual's skills or knowledge base related to the action, and communality embodies the characteristic elements of the PCoP (i.e., shared leadership, shared ownership, social identity). Optimal synergy between these four variables strengthens the substantive communication and cooperation between the members of the PCoP.

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Chapter 31
The Digital Textbook: New Learning Paradigms in Primary Education—A Portuguese Pilot Project

José Lagarto, Carla Ganito, and Hermínia Marques

Abstract This chapter presents the preliminary results of a 3-year project on digital textbooks made available on a tablet, taking place in the Cuba school district of the Portuguese Alentejo region. The project involved two classes of seven graders. We will focus the analysis on student behavior and attitudes. The research draws upon a questionnaire whose goals were to evaluate the digital proficiency of students, to understand their perceptions, and to evaluate the project's impact on learning and grades. Upon examination of the results, it becomes clear that students feel more motivated but this motivation does not correlate with grade improvement.

Even at this preliminary stage, the research highlights the importance of a paradigm shift in the teaching process and the need to focus on acquiring skills rather than on improving grades.

Keywords Digital textbooks • Portugal • Tablets • Student behaviour • Learner attitudes • Digital proficiency • Teaching process

Connected Readership

Readers worldwide are taking up new reading practices and the opportunities offered by mobile devices such as smartphones, tablets, and eReaders (Baron, 2015; Cardoso, 2015; Rainie, Zickuhr, Purcell, Madden, & Brenner, 2012). Mobility is increasingly important in people's daily lives (Unesco, 2014) and as such we have to take it into close consideration when researching on readership (Baron, 2013). The practice of reading has always been mobile, but the new digital environment offers a new kind of mobility, "a mobility that is connected, networked and

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collaborative" (Cardoso, Ganito, & Ferreira, 2012). We now speak of locative media (Frith, 2015) as, besides content, context also plays a major role.

Mobility contexts are often used as a time to read, and connected devices allow not only to carry a greater amount of books, but also to take advantage of being online to enhance the reading activity, by accessing complementary information or having the possibility to easily manage a digital library or reading notes. Mobile digital reading is also a more private practice, although it may, at the same time, be a more connected one—it occurs in devices that tend to be personal [and hardly sharable] and users may take advantage of the private-public space of the Internet while reading on devices that do not have an identifying cover that would allow others to know what is being read.

The survey on digital reading[1] allows us to map the global digital reading landscape, including Portugal. One of the main conclusions is that reading matters (Cardoso, 2015). In response to the question "when purchasing a device with internet access, was the ability to read texts such as books, magazines or newspapers important in your purchase decision," 61 % of the global sample answered affirmatively. Books are definitely going digital with the majority of the respondents, 58 %, having already read a book in digital format. Another conclusion that can be drawn from this survey, in line with previous research (Griswold & Wright, 2004), is that digital reading often functions as an extension of paper, as the individuals who read more on paper are also the ones reading more in digital formats. Hence, digital reading should not be regarded as a replacement activity but rather a cumulative one.

A common misconception of digital reading dismissed by the results of the survey is that age functions as an obstacle to the uptake, while, as with so many other digital practices, it is much more correlated with the level of education than age itself (Cardoso, 2015). Thus, one of the main challenges posed by the technological dimension of digital reading is the development of digital literacy skills (OCDE, 2015).

Digital Technologies and Learning

Fifteen years ago Prensky (2001) posited that young people, "digital natives" (idem), handled digital tools easily and their brain were thus preformatted for the new demands of a digital world. In contrast older people, "digital immigrants" (ibidem), would find it more difficult to survive in the new digital environment, which did not exist when they were born or even when they were teenagers. This has been taken up by other authors (Oblinger & Oblinger, 2005) and has been very popular in the media.

Subsequent studies (Bennett, Maton, & Kervin, 2008; Buckingham & Willett, 2006; Cardoso & Espanha, 2010; Davies, Coleman, & Livingstone, 2014; Lagarto, 2013; White & Le Cornu, 2011; White, Manton, & Le Cornu, 2009) have shown

[1] 'Digital Reading and the Transformation of Reading Stimulus and of Book Institutions' (2015). Online Survey of 16 countries: Australia, Brazil, Canada, China, France, Germany, India, Italy, Mexico, Portugal, Russia, South Africa, Spain, Turkey, the UK, the USA.

that there is no evidence that young people are in fact more digitally competent and that they may, indeed, require training on issues concerning digital tools. And if younger people lack this training, the elder, "digital immigrants" (Prensky, 2001), need to understand the mechanisms of these new tools. We can therefore infer that to live in a digital world requires a learning period, which may be more or less prolonged depending on individual characteristics.

Nevertheless, it can be asserted that young people are immersed in technology and engage with it in a natural way, as shown in a study by EDUCAUSE (Dahlstrom & Bishsel, 2014), which questioned about 1.5 million students in 74 countries. However, being a "digital native" (Prensky, 2001) does not necessarily confer competence. Each individual should move towards acquiring a non-digital innate intelligence, a kind of digital wisdom according to Prensky (2009), and that could be the basis of full citizenship.

In deploying technology-rich environments, we must therefore take into account some of these fundamental aspects. No less important is the issue of access. Without a true democratization of access to technology and the Internet, users cannot take full advantage of the features that the digital world is able to provide (Bennett, Maton, & Kevin, 2008; Cardoso & Espanha, 2010; Ganito, 2011; Lagarto, 2013; White & Le Cornu, 2011).

Digital Technologies and the Learning Experience

There are several research studies that seek to understand whether or not there is a positive impact of ICT on student learning. It has been suggested that the use of ICT may increase the level of involvement and motivation, in particular students and teachers (Balanskat, 2013; Clark & Luckin, 2013; Clarke & Svanaes, 2014; Dwyer et al., 2007; Nishizak, 2015). Even parents, when requested to express their opinion, commonly indicate that children have a more positive attitude towards homework and feel encouraged to talk more about school activities (Burden, Hopkins, Male, Martin, & Trala, 2012). This type of learning is enhanced if developed by teachers who believe that students learn more and better with ICT. Beliefs, knowledge, and skills of the actors play a key role here.

However, other studies have claimed that ICT do not necessarily imply a better teaching/learning process. For example, a research project carried out at the State University of Campinas (Dwyer et al., 2007) conducted a literature review to establish a connection between the use and nonuse of computers in schools and student's performance. The researchers were able to conclude that students at the three levels of education under analysis (students from the fourth and eighth levels of elementary school and the third year of middle school), regardless of social class, had a lower school performance when they used the computer intensively. In the case of the poorest students in the fourth grade, the moderate use of computer worsened the exam results of Portuguese and mathematics. This study also concluded that students who did not use the computer had worse exam results than those who rarely used it.

Another study conducted in Quebec with more than 6000 students (grades 6–10) and 300 teachers, who had previously not used the iPad for learning tasks, concluded that "few or no students or teachers reported that the touchpads enabled them to learn more" (Karsenti & Fievez, 2013: p. 40).

However, the number of studies that clearly demonstrate how the integration of ICT in education favors the learning process, in addition to developing skills that go beyond the cognitive, is much higher. The use of ICT is thus being considered a major opportunity in education, one that goes beyond the formal curricula (Clarke & Svanaes, 2014; Heinrich, 2012; Law, Pelgrum, & Plomo, quoted in Tornero & Pi, 2013).

The ICT Impact Report (Balanskat & Blamire, 2007) tried to establish a direct causal link between the use of ICT and the results of students in examinations and tests, and indicated, already in 2006, a relatively clear positive impact of ICT in the learning process. When the European Schoolnet study was conducted, tablets had not yet appeared and the study included only computers and laptops, although there were already references to the concept of mobile learning. The results presented seemed to make clear the positive impact of technology on students' learning processes.

From the Computer to the Tablet: What Makes It Different?

With the current uptake of laptops and tablets, an in-depth discussion of common trends among PC and tablet usage is much needed.

The scarce existing literature on the subject has shown, interestingly, that one of the first advantages identified in the use of tablets at school has to do with reducing the weight of backpacks (Hallissy, Gallagher, Ryan, & Hurley, 2013). But there are other advantages related to the use of tablets in the classroom. Students report that, with their tablets, they communicate more online with peers and teachers, and access useful information to work in the classroom much faster (Clarke & Svanaes, 2014).

Despite studies questioning the effectiveness of ICT (and tablets) in learning processes (Clark & Luckin, 2013; Hu, 2011), there are already substantial investigations indicating that students show more motivation to study and refer positively the collaborative work that they are more likely to develop with their colleagues. In a study on the responses of students regarding the use of the Ipad, by Hallissy et al. (2013), it appears that, in general, students replied very favorably to the use of iPads, referring an increase in terms of how and when iPads are used. The technology could thus prove effective in the processes of teaching and learning. However, it should be taken into account that the use of tablets cannot be an end in itself but a beginning (Hallissy et al., 2013). In fact, for a successful implementation of the use of ICT (and tablets), teacher training will always be a crucial aspect (Hallissy et al., 2013).

Johnson, Adams, and Cummins (2012), in the NMC Horizon Report: 2012K-12 Edition, make a prospective analysis of the importance that technologies can have for students and teachers of secondary schools. Among several findings, the report highlights the inevitability of a growing penetration of technology in the lives of citizens, the gradual change of teaching paradigms, and the investment in tablet use policies, allowing equipment for students (1:1) in learning areas.

The NMC also refers to a strong short-term trend (in 2013) with the rapid evolution of two types of technology—smartphones and tablets. Mobile phones, although often still banned from the classroom and school, have started to exhibit obvious utility features for learning. Tablets now include features that promote reading, and the price at which these devices are now available on the market makes them superior as utility tools to laptops and smartphones (Johnson et al., 2012).

We can conclude that there is significant consensus on research into the benefits of using tablets in teaching and learning processes. If the weight of the school bags appeared at the top of the advantages, particularly for parents, there is also some convergence on students' motivation, which is higher now, on greater involvement in collaborative learning, and on the perception of increasing digital literacy of students and teachers.

Undoubtedly, all these factors will contribute to better learning and are not always easy to observe, given the many variables at play in assessment practices, particularly summative.

Parents, in general, seem receptive to innovation and understand that the use of technology in school is beneficial. However, they still show some reluctance in relation to security, associated costs, and, in some cases, the effectiveness of the equipment in the learning process (Clark & Luckin, 2013).

Another positive dimension of using tablets is related to its ubiquity and the ease with which students can easily access informal learning sources. Students are also more motivated to personalise the device, adjusting the features to their personal tastes and learning styles. Personalised access and individual ownership are reported as being key factors in a successful adoption process (Clark & Luckin, 2013).

Finally, one might also take into account cases such as the one also referenced in Clark and Luckin (2013), where researchers had access to students' files and were able to identify what apps they were installing. Tablets function as a support for the development of skills associated with specific needs such as reading difficulties.

Considering all relevant available literature, we can state that the use of tablets, when framed by a well-organised implementation process, can play a positive role in student learning. The motivation, the ability to communicate faster, and, more often, informal learning and ubiquity justify this assumption.

Issues such as cost, misuse, damage, network problems, or the smaller digital skills may not override the increase in motivation and school productivity, enthusiasm, interest, commitment, creativity, independence, and self-regulation (Burden et al., 2012; NMC, 2012; cited by Clark & Luckin, 2013).

Based on these evidences, we have been tracking a pilot project on digital textbooks. The results of the first year of the project are presented in the next section.

The Pilot Project: Digital Textbooks

The project on digital textbooks (ManEEle), coordinated by the General Directorate of Education—Management Services of the Alentejo Region, was implemented within Cuba's School Cluster, with two classes of the third cycle of basic education. The project started in September 2013 and involved two classes that were then in seventh grade, foreseeing its monitoring over the entire cycle route.

With an expected duration of 3 years, this pilot project was organised in two stages. The first phase, covering the school year 2013/2014, focused on students and teachers adapting to the use of textbooks in digital format, made available on a tablet, while simultaneously verifying which technological solution would be the most appropriate methodology for educational strategies and diagnosing any obstacles to this educational experience. With this first stage of diagnosis and evaluation, one could draw conclusions that would allow the modification of future actions. As such, over this first year of implementation, an exploratory study was developed to identify difficulties and provide insights for future improvement of the project. The second stage, corresponding to the two subsequent school years, refers to the main phase of project implementation with the "use of advanced technologies and teaching methods in order to provide students with more and better learning" (ManEEle project).

Methodology

Ongoing research focuses on issues related to the impact caused by replacing paper manuals with digital textbooks on tablets and students' behavior and attitudes. The study also includes an analysis of the attitudes of teachers, parents, and school leaders regarding the use of digital educational resources available on mobile devices.

This is a predominantly qualitative and descriptive research and it involves two groups that started the seventh grade in September 2013, at the Cuban School District, a total of 17 teachers, 42 students, and their parents.

An ongoing longitudinal research was established to anticipate difficulties and provide insight for improvements. As a starting point, the following central research question was defined: "What is the impact of replacing textbooks with digital educational resources available on tablets?"

From this central issue, and taking into account the objectives foreseen for research, a set of sub-questions was outlined. In this chapter, we present the results of the survey on students, while follow-up research will analyze responses from teachers and families. The goals and questions related to students are summarised in Fig. 31.1.

Monitoring of the first year of the experiment was conducted through the use of various instruments, and those included questionnaires to students, teachers, and parents, interviews (focus group) to students and teachers, classroom observation, and document analysis, particularly of late period reports, per class.

Goals	Sub-questions
Evaluate the digital proficiency of students, in particular as regards the handling of equipment and software used in the study	Do students demonstrate digital proficiency to handle the equipment and software appropriate to the study?
Unveil students perceptions about their motivation and development activities and expertise in a technology-enhanced environment	Have students become more motivated and developed in class activities and skills not previously developed in technologically enriched environments?
Evaluate project impact on students learning and grades	Has student learning materialized in rankings and, when compared to previous school years, do they fall under normal standards for this grade level?

Fig. 31.1 Objectives and research sub-questions

Data Analysis

With the start-up year of the project completed, it was important to assess the impact of using the tablet and the degree of satisfaction of students, teachers, and parents. Thus, between May and June 2014, questionnaires were applied to each of these audiences and then analyzed autonomously. In the following subsections, we focus our analysis on students.

The Students

The questionnaire to students applied by the year director in May 2014 received 37 valid responses, which corresponds to 88 % of the seventh-grade students involved in the project, of which 57 % were male. Data analysis shows that the connection between family and school is usually established through the mother, since mothers are the ones in charge of education in 86 % of the cases. Situations in which the father (8 %), siblings (3 %), and grandparents (3 %) appear as guardians are uncommon.

Regarding the educational background of parents, it is also the mother who shows the highest level of education: 54 % attended secondary or higher education and only 35 % of fathers were in the same situation.

Before school year 2013/2014 started, all students, except for one, had access to a tablet or computer in their family background. The notebook was present in 84 %

of households and possession of tablets approached computers, covering a little more than half of respondents. It should be emphasised that before the project began, nearly half of students (43 %) did not have exclusive use of the computer in the family context. For this group of students, the project enabled the tablet to become an element of personal use which was previously non-existent.

The space where children access the Internet has an impact on several factors such as portability, privacy, and security. For students participating in our study, prior to the start of school year 2013/2014, almost all (97 %) had Internet access at home. This percentage is higher than the results obtained by the Survey Network Society 2013 (Cardoso, Mendonça, Lima, Paisana, & Neves, 2014), according to which only 57 % of Portuguese households had Internet connection.

As in the rest of Europe, another Internet service space was the home of friends or relatives (41 %), although the percentage is slightly below the European average as mentioned in the project EU Kids Online (53 % of European children connect to a network at friends' house). In contrast, before the implementation of the project, school was a space where Internet use was of little relevance, with no students referring to its use in the classroom, with teachers. Although about half the students accessed the Internet via mobile devices such as the mobile phone (51 %) and tablet (46 %), the computer was still the preferred equipment (89 %).

When asked about three activities (play, study, and communication with friends and family) that academic literature has mentioned as the most common among children and young people, it was determined that values were much lower than those mentioned in other studies. So Ólafsson, Livingstone, and Haddon (2013) report that over 80 % of children between 9 and 16 years old use the Internet to play or perform work related to school. For seventh-year students of the Cuban grouping, only a quarter claimed that they used the Internet to study and less than 40 % considered that the use was for games (37 %) or had a communicative purpose (38 %).

One of teachers concerns when dealing with the Internet is linked to the dangers of its use and how to control them, or the parental mediation that should be exercised. In our study, almost half of students (49 %) reported that parents let them be on the computer whenever they wanted to, while the others, except for one who had no computer, indicated that there were rules for its use.

The questionnaire included indicators such as tablet use practices, difficulties encountered with its use, the scope of mobility and value assigned to it, and how parental mediation is perceived. What types of activity have students held with the tablet? To answer this question, we focused our research on four activities: three of them related to school work (writing notes, recording videos, and taking pictures), and the other associated with games: 62 % stated that the tablet is not used daily to play and only a minority (16 %) agreed that it was used for play.

Video recording and photographing with the tablet for school work are activities not rooted in the practices of most students, with only a residual percentage performing it frequently. Although it is still higher than the percentage of those who frequently use the tablet to write lecture notes (16 %), the truth is that 38 % report not to do it. These results allow us to infer that teachers do not often seek out this type of activities, which in some curriculum areas could be very useful: audio recording in teaching a foreign language, video in visual education, etc.

The diversity of applications (apps) available and the possibility of customization of access and tablet use, tailoring it to individual user needs, are two of the potential areas recognised by researchers in this field that can be used in education (Clark & Luckin, 2013; Johnson et al., 2013). Given this premise, we questioned students about the applications they downloaded to their tablet, in addition to the ones that were originally installed. It is noteworthy that the majority (62 %) mention not having downloaded any application. However, within the space reserved for comments in the questionnaire, a student said that "there should be more control over the apps installed in some of the tablets." Thus, at a subsequent stage of research, it would be important to understand the reasons that lead to such a small percentage of apps downloaded, especially when one considers that "personal access" and "single use" are two of the elements that affect the successful adoption and effective use of mobile devices (Burden et al., 2012, quoted by Clark & Luckin, 2013).

As for digital literacy, 62 % of students expressed full agreement with the statement "it is easy to use tablets" and more than half (54 %) indicated that they did not have difficulties using it. However, we must not forget that for four students (11 %) the use of tablet was not easy, and almost a quarter clearly admitted difficulties, while 32 % had problems reading the manuals on these mobile devices. If we add the 27 % of undecided, we have here a clear reason for concern.

Confirming their status as digital natives, the data gathered reveal that students feel autonomous using the equipment, as they generally do not ask for help to solve problems. Only 11 % admitted asking their parents for help to use the tablet. Yet, more than 70 % of students confirmed that their parents have tried to learn something more about the tablets, which shows some engagement in the school life of their children.

The use of digital technologies can bring about generational conflicts within the family. We placed a question that tried to identify this and found that 16 % of students report the existence of conflicts, which coincides with the results of questionnaires given to parents. These conflicts may indicate that parents believe that their children use the equipment improperly and impose rules and restrictions.

As a positive factor, it should be highlighted that more than half of students say that they show their work on tablets to parents and guardians, revealing still a trustful family relationship.

Related to these conflicting issues may be the imposition of rules for the use of computers in the family context. Several issues such as the safe use of the Internet can justify this option. About 40 % of students report parental monitoring, which for many of them does not lead to any conflict.

It is also important to know what kind of rules were imposed by parents. We found that parents involved in the experiment have attitudes that are recommended in the literature on the safe use of the Internet, namely the establishment of rules for the type of applications that the children can use (43 %) and the use of the site of the tablets (33 %). Interestingly, only 20 % of parents impose rules on the time of use. There are still parents (5 %) that only allow the use of the tablet to study.

As might be expected, most students agree that they do not spend too much time using the tablet. Only 14 % (N=3) state clearly that they are aware of spending too much time using the equipment. This seems normal since, although the technology is pervasive, it did not seduce young alike.

As for the impact on the teaching/learning process, students report that tablets motivate them to school (43 %), but few reveal that they read the manual more now (only 22 %), or like to do homework more (35 % say no). About half of the students explicitly declared that they like to read books on paper more than on the tablet.

This question seems rather contradictory between perceived motivation and practices. We assume that this result has to do with the fact that this was the first year of the experience and it is likely to change over the 3 years of the project.

However, it should be noted that, in the perception of students, teachers do not teach better—only 16 % said that they learned better—and students do not learn more with tablets than with books—only 24 % said that they learned better with tablets.

It is recurrent in literature on tablets to mention the communicational effect that they promote, in particular by facilitating the exchange of messages between peers and between students and teachers themselves (Clark & Luckin, 2013). In fact, students refer that and, without any doubt, communicate more with peers and teachers due to tablet use (41 %, in addition to the 38 % of undecided on this finding).

The perception of the economic impact of tablets, with regard to reducing the costs of manuals, was also one of the indicators used in our questionnaire. In this case, 57 % of students considered it positively because it sidesteps paying for the books. In the space reserved for comments or suggestions regarding the project, one of the students reinforced this idea noting: "I think this project is good because we do not spend money to buy the books."

In addition to hindering the mobility and some of the recreational activities of children and youth, excess weight in backpacks can lead to changes in body posture at the level of the spine ("lumbar hyperlordosis, cervical tilt"), shoulders ("gap and protrusion of the shoulder, scapula winged"), and lower limbs ("increased valgus angle of the knee") (Santos et al., 2009). Thus, students were questioned whether tablets were good because they helped avoiding heavy backpacks, and most students (62 %) expressed complete agreement with the statement.

And how do students perceive the value of the project? If it were them, would this project be extended to the whole school? Student responses are divided almost equally between those who would generalise tablets to other classes and those who have the opposite view. One student wrote as an observation that he considered this project "more innovative and more motivating," while another recorded it was "bad."

Based on these data, we considered it important to uncover the legitimate reasons for these opinions. Again, the space reserved for comments concerning the project suggests some interpretative clues. It should be stressed that two students answered "no" to the generalization of tablets, but the observations mentioned "Tablets are very good," or in question 18 [If it were up to you, would this project be extended to the whole school?] said "no because only our class is deserving." Therefore, in general, students like the project, but if it were extended to other classes, they would no longer have exclusive participation in something innovative. This positive social evaluation of the idea of the device (tablet ownership) and the elevation of the status of groups over the others is also present in the review of a third student: although not widened to the entire school, he said that "this project could also be offered to the students in 8th year." It must be recalled that in the following school year, these students will be in eighth year.

Conclusion: Do They Learn More?

These findings focus primarily on the student dimension of the research project and on answering the sub-questions related to enhancing the learning process.

As for the concern whether students demonstrate digital proficiency, students, for the most part, state that they do not have problems with the use of tablets. They affirm that they do not use the tablet daily for games, and that they are more motivated by the simple use of the equipment. In addition, they do not ask for help from parents or teachers to use the tablet. However, we find that they have downloaded games, and some (a few) students deleted the school manual in order to get more space for their recreational activities.

Another important question is related to motivation. The research tried to confirm whether students have become more motivated and able to develop in-class activities and skills that they did not develop in non-technologically enriched environments. In fact, students consider that they feel more motivated to use the tablet, a view shared by teachers. However, this motivation does not have proper matching in school results.

Albeit not substantially, students end up using the tablet in activities that would not exist without it. Naturally and steadily, access to manuals, but also research activities on the Internet, was performed with some frequency, allowing students to acquire multiple skills.

The low level of use of other features, in addition to access to digital textbooks, also holds up with the attitude of teachers who, throughout the year, did not request much tablet use for other activities. It should be noted that students have the perception that they do not learn more by having the tablet, and most of them prefer reading the manual on paper than on the tablet. In any case, more than half of the students stated that they took notes on the tablet, and 16 % of them indicated that they did it quite often. About 30 % of students took photographs and made short videos for schoolwork.

Finally, the study sought to assess if the student learning process materialised in their grades and, when compared to previous school years, if it fell under normal standards for this grade level. The study we conducted is not conclusive and is not even completed. Nevertheless, we should note that, at the end of the year, in a joint meeting, it became clear that, in general, expectations had been exceeded. In fact, analyzing the profile of students grades, it would appear that the tablet has not had a negative impact on learning. The requirement stated by teachers, the grades obtained, and the number of students retained show that students would not have had better grades and would not have had learned more if they had had nothing but the tablet to access the school textbook. In fact, we can say that even in one of the target disciplines (Portuguese), students maintained their average scores of the previous year.

What are then the critical success factors for the integration of tablets and digital textbooks in the teaching-learning process? A global analysis of the data obtained in this research work allows us to identify a set of factors that can contribute to the successful implementation of the use of tablets in the learning process. This change in strategy can effectively start by replacing the manual on paper for digital books, but it also can, and should, allow the use of a diverse set of existing digital tools to support learning and enable a paradigm shift in teaching processes. Thus, the analysis of available data, including literature, suggests that there are critical factors that must be taken into account in the planning of a project of this nature. We pointed out a set of recommendations that should be taken into consideration in planning and implementing projects aimed at introducing tablets in the classroom and replacing paper manuals with digital textbooks.

Tablets must display appropriate characteristics to their use, including robustness, large data storage, and good processing speed. It is necessary to take into account the need of technical support for hardware and software that eliminates operating constraints of equipment and peripherals. Also, wireless networks should have bandwidth and high coverage on campus.

Teachers should be provided with training in the use of tablets and in innovative teaching practices, in order to refocus the learning process on students. This training must be done on an ongoing basis within the school, but also in close coordination with training centers and universities.

Institutional leadership must offer express and effective support to the changes you want to see implemented in their educational territory.

Communities of practice of teachers for performance enhancement and sharing practices should be induced using virtual environments appropriate to learning.

Parents and guardians should be involved systematically in this process, guiding them to monitor the students in their learning and in particular for the proper use of Internet at home.

The school library and teachers should combine efforts to articulate their work and contribute to the continued promotion of the use of digital media for reading, in addition to the digital manual.

Local (municipalities, businesses, and other organizations) or national (publishers) partnerships must be created as costs associated with digital manuals are substantially lower to printed manuals.

Students must also have continuous monitoring, ICT classes, or clubs/workshops to learn how to use ICT and tablets. Their digital proficiency does not often exceed the games and the use of social media. Writing a text or making a presentation can be tasks that pose unexpected problems.

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Handbook on Digital Learning for K-12 Schools

Ann Marcus-Quinn and Tríona Hourigan

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In the original version of Chapter 1, the first paragraph in page 4 was published with errors and should read as follows:

Chapter 9, by Ben Murray (National Council for Curriculum and Assessment, Dublin, Ireland) and Sinéad Tuohy (Junior Cycle for Teachers, Monaghan, Ireland) details the participation of Ireland as one of seven European countries participating in the EUfolio Classroom ePortfolios project. This was a 2-year project, from May 2013 to May 2015, which was funded by the European Commission under the framework of the Lifelong Learning Programme. The chapter focuses primarily on the experiences of the Irish pilot, and in turn highlights specific examples of where ePortfolios were used to encourage a collaborative approach to assessment and learning. In this context, the authors note how the various interactions between participating teachers and students actually opened up the learning process, thus allowing the establishment of a more supportive culture which enabled formative practices in the classroom to emerge and develop.

In the original version of Chapter 22, Andrea Raiker and Patrick Carmichael were not listed as co-authors.

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