Building Bridges
Rethinking Literacy Teacher Education in a Digital Era
Clare Kosnik, Simone White, Clive Beck, Bethan Marshall, A. Lin Goodwin and Jean Murray (Eds.)

Foreword by Neil Selwyn

Literacy learning continues to be central to schooling, and is currently of major concern to educators, policy developers, and members of the public alike. However, the proliferation of communication channels in this digital era requires a fundamental re-thinking of the nature of literacy and the pedagogy of literacy teaching and teacher education.

This text brings together papers by experts in teacher education, literacy, and information technology to help chart a way forward in this complex area. Because of their background in teacher education, the authors are realistic about what is appropriate and feasible – they do not just jump on a technology bandwagon – but they are also able to provide extended examples of how to embed technology in the practice of teacher education.

“Taking a multi-disciplinary perspective (literacy, teacher education and digital technology) and informed by a range of empirical studies, policy analyses and scholarly reflection, this book makes a unique contribution to the literature on one of education’s most pressing challenges: how we prepare teachers of literacy at a time when understandings of literacy are expanding. Chapters by leading researchers are complemented by those offering illuminating vignettes of practice that, in turn, provide opportunities for interrogation by the rich theoretical toolkit that characterizes the field. The book is thoughtfully structured and manages a coherence that is rare in edited collections. An impressive and heartening read.” – Viv Ellis, Professor of Education at Brunel University, England and Bergen University College in Norway

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Rethinking Literacy Teacher Education in a Digital Era

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What does it mean to communicate? to know? to be literate? to learn? in a world crowded with multimodalities offered by the myriad of digital platforms, text messages, social networks, blogs, virtual friends, tweets, emoticons, and SMS codes…more importantly, What does it mean to teach in this complex communicative environment? These pressing questions are taken up in this collection of thoughtful and provocative essays that cross physical, national, and disciplinary boundaries to examine current practices, offer compelling illustrations, and propose novel solutions. Educators, researchers and policy makers wrestling with emerging dilemmas of curriculum and teaching given a rapidly digitizing 21st century will find this volume to be an accessible, refreshing, and substantive read.

– Associate Professor Ee-Ling Low, Head, Strategic Planning & Academic Quality, National Institute of Education, Nanyang Technological University, Singapore

We live in an exhilarating time when global citizens, including teachers and teacher educators, send and receive messages via social media, across vast distances within seconds. Yet integrating digital technologies into the foundations of teacher education continues to be a daunting task. The data and insights herein are timely, challenging, and vitally necessary. Readers will come away with broadened understandings of literacies, defined by everything from electronic communications to indispensable face-to-face human relationships. In short, the authors provide a must-read volume for all in teacher education, literacy education, and digital technology, who seek to rethink and reform their multidisciplinary fields.

– Celia Genishi, Professor Emerita, Teachers College, Columbia University

Taking a multi-disciplinary perspective (literacy, teacher education and digital technology) and informed by a range of empirical studies, policy analyses and scholarly reflection, this book makes a unique contribution to the literature on one of education’s most pressing challenges: how we prepare teachers of literacy at a time when understandings of literacy are expanding. Chapters by leading researchers are complemented by those offering illuminating vignettes of practice that, in turn, provide opportunities for interrogation by the rich theoretical toolkit that characterizes the field. The book is thoughtfully structured and manages a coherence that is rare in edited collections. An impressive and heartening read.

– Viv Ellis, Professor of Education at Brunel University, England and Bergen University College in Norway
To teacher educators and teachers around the world whose creative, skillful, and dedicated work is helping us meet the challenges of the digital era.
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FOREWORD

Anyone interested in technology and education will know that there is already a wealth of writing on the subject. Increasingly the most compelling commentaries are those circulated through tweets, blog posts and other forms of ‘fast scholarship’ that new media scholars are understandably attracted toward. A platform such as Twitter offers a fascinating stream of rapid responses and immediate reactions to what is a fast-changing area of debate. In contrast, then, a book such as Building Bridges marks a decidedly ‘old school’ approach. Yet in many ways this should be seen as a strength rather than weakness. A 200 page edited collection certainly provides a welcome break from the online chatter and churn that passes for informed discussion in this area. Perhaps, then, this book’s virtues lie in what might appear to be its outdated approach.

Firstly, this is a book that is admirably old-fashioned in terms of how it was produced. Rather than constituting a quick cut-and-pasting together of fourteen disconnected essays, Building Bridges is the culmination of collective conversations that developed over time. Despite being scattered around the world, the authors and editors made the effort to meet and talk through these topics in person. They then worked over a prolonged period to produce this long-form book. In terms of ‘digital scholarship’ and the ‘accelerated academy’ these might all be deemed inefficient ways of going about things. Yet I am sure that the contributors consider their end-product to be much richer as a result. This project should remind the Twitterati what can be achieved through a sustained project of face-to-face discussion and long-form writing.

Secondly, Building Bridges is pleasingly old-fashioned in terms of what its authors are discussing. It might even be reasoned that the book contains a set of timely contributions – not because they are particularly new or ‘of the moment’ but because they tackle topics that have fallen somewhat out of sight. While the 1990s and 2000s was a period of ongoing deliberation of ‘new literacies’ and ‘multi-modalities’ these are no longer the hot topics that they once were. Imperatives of ‘critical digital literacy’ and ‘twenty-first century skills’ have also begun to disappear from policy priorities, funding streams and call for papers. Instead recent discussions of technology and education have taken a distinctly computational turn – addressing the challenges posed by big data, analytics, algorithms and coding. As such, Building Bridges might serve to remind people working in the area of education technology of the contribution that literacy educators can still make. It might even be that the book leads to the rebuilding of some old bridges.

Thirdly, this book is old-fashioned in terms of who is being talked about. Few writers currently working in the area of technology and education seem to care much for classroom teachers … and even fewer seem to care for teacher education.
If anything, many commentators appear distracted by questions of how digital technology might do away with the need for teachers altogether (as evident in discussions of teacherbots, virtual assistants and self-organized learning). In this sense, Bridges marks a commendable attempt to restate the importance of ‘the teacher’ in the digital age. Teachers and teacher education are unlikely to fade away as quickly as some technologists would like us to believe. As such, this book serves as a valuable corrective to such (mis)assumptions.

In many ways, then, these fourteen chapters remind us how educationalists working in the literacy tradition have long been attuned to the broader contexts of technology use, especially in comparison to disciplines with more technical and scientific pretentions. Indeed, some of the most rounded accounts of education and technology have been those produced by literary scholars working along sociocultural and sociopolitical lines. Here one thinks of Michelle Knobel, Colin Lankshear, Bill Green, James Gee, Gunter Kress and others. Of course, the momentum of these authors’ work has faded during the 2010s, yet perhaps new titles such as Building Bridges herald a revival of this tradition. Certainly, the chapters in this book provide a decent account of technology use as embedded social practice – highlighting the history, philosophy, ethics and poetry of technology use in education.

Whether or not we are on the cusp of a full-scale renaissance, I have always appreciated how literacy scholars bring a subtly critical dimension to discussions of technology and education. This quality is certainly evident in many of the chapters in Building Bridges. These are accounts that do more than restate the exaggerated promises that often pervade discussions of digital education. Instead these accounts are suspicious of the reductive ‘technology imperative’, and question the cultural conservatism of official discourses of ‘ICT’ and ‘technology enhanced learning’. Many of these chapters point to the complicated and constrained realities of teacher education in universities and schools. While no one is denying that teacher education and literary education are in the midst of significant change, the key questions running throughout the book relate to if/how teacher educators are able to influence this change.

Of course, few commentators want to be seen as out-of-touch ‘dinosaurs’ railing against ‘innovation’ and ‘progress’. Yet as Building Bridges illustrates, being critical need not involve opposing the existence of digital technology altogether. One can speak against current forms of technology use in education without engaging in relentless doom-mongering. Instead the best chapters in this book also suggest ways of pushing back against current forms of technology use in schools and teacher education, and point hopefully to realistic alternatives. In this respect I would hope the book has something to offer all readers, from the most digitally immersed to the most digitally disinclined. These are conversations that everyone in education needs to be part of, and this book marks some very useful starting points.

Neil Selwyn

Melbourne, January 2016
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INTRODUCTION

What does it mean to be literate in the twenty first century and how can teachers and teacher educators contribute to building a literate society? Our understanding of “literacy” is undergoing dramatic changes as an array of communication channels (e.g., text messaging, social networking, blogging) has extended and blurred the boundaries of communication and forms of knowledge construction (Kress, 2010). The fact that literacy now encompasses a broad set of practices necessitates a revision of traditional reading and writing programs in schools (Gee & Hayes, 2011), which in turn requires changes to teacher education. This constant change in how we communicate means that we need teacher educators who can incorporate digital technology into their courses and facilitate discussion on being literate in the 21st century. As the field of literacy evolves, teacher educators must rethink what literacy encompasses and revise their courses accordingly. As Williamson (2013) advises:

Our courses must invite students to take stock of how their literacy instruction provides kids with access to learning opportunities to understand the resources and the practices that are available – and then to envision how these can be adapted and enhanced to achieve the rich, rigorous literacy goals that we set for our youth. (p. 2)

According to Boling (2005), however, “research has revealed that teacher educators do not always have the knowledge, skills, or dispositions necessary for meaningfully integrating technology into their classes” (p. 3). Often use of digital technology is an afterthought, something tacked onto a course (Bullock, 2011). In order to address the complexity of literacy in our 21st century we need to move beyond the traditional boundaries of the disciplines. As teacher educators struggle to address the increasing complexity of education, many have embarked on initiatives but with mixed success (Kirkwood, 2009; Selwyn, 2011). We believe part of the problem in moving forward is that most initiatives focus on a single issue (e.g., digital technology) whereas a multi-disciplinary approach is needed.

Building Bridges: Rethinking Literacy Teacher Education in a Digital Era builds on a symposium we held in London, England in June 2014, bringing together a team of experts from different disciplines namely teacher education, literacy education, and digital technology. As Gee and Hayes (2011) argue for a multi-disciplinary approach to research: “Understanding complex systems requires the work of more than a single lone expert. It requires a team of experts” (p. 73). The consensus among
this international group of researchers was that we need to rethink our practices in teacher education and inservice education in relation to digital technology and literacy education if we are to prepare student teachers more fully and support teachers more adequately. All felt we must be “in conversation” with experts in a variety of disciplines and with practicing teachers. Further, all agreed we need many more examples of exemplary practice of integrating digital technology into literacy courses. *Building Bridges: Rethinking Literacy Teacher Education in a Digital Era* addresses this gap in the literature. It is a powerful set of chapters focusing on a curriculum area – literacy – while making links to digital technology with special attention to teacher educators. This will be one of the few texts rooted in a specific discipline (literacy) that makes multiple connections with other aspects of education. The goal is ambitious; however, our contributors have the skills and knowledge to make significant progress with this mandate.

The contributors to the text are all recognized researchers with strong connections to both teacher education and schools. They have a deep understanding of the context of higher education and are fully aware of current issues in schooling, thus making their work relevant to many. They do not write for just one audience or have a narrow focus – they can do what Gee and Hayes (2011) suggest: implement a multidisciplinary approach. And given their extensive experience in teaching and research, all have many examples of exemplary practice to present in their writing.

The matters with which this book is concerned have been taken up by many literacy teacher educators in their everyday practice, keen to bridge current and progressive literacy education and address what Dooley, Exley, and Comber (2013, p. 67) describe as “the perennial issue of how do we attend to both the technical and the critical dimensions of literacy education.” For many literacy teacher educators, their endeavour to address this question has led them to adopt new models and approaches, for example collaborative work between student teachers and school-based teachers focused on inquiry into the serious intellectual work of literacy teaching (Cochran-Smith, 1991). Creating spaces where student teachers can see and hear inclusive and critical approaches to complex literacy teaching with diverse student communities remains a key priority and an ongoing challenge (Dooley, Exley, & Comber, 2013).

The text has four sections. Section 1 contains anchor chapters concerned with key issues of digital technology, literacy, and teacher education. Presenting historical roots and then moving to current research, they provide a thorough grounding in their respective areas. Shawn Bullock addresses issues regarding digital technology in education; Lydia Menna outlines the changing nature of literacy; John Yandell looks at the impact of policy on teacher education and literacy education in England; and Judit García-Martín, Guy Merchant and Jesús-Nicasio García-Sánchez discuss preparing to teach 21st century literacies.

Section 2 includes conceptual papers and case studies of exemplary practices related to the use of digital technology in literacy courses in teacher education. Both kinds of chapter offer suggestions for ways to rethink teacher education. Sam
Twiselton draws on her review of different approaches to teacher education in England; Sue Dymoke provides an in-depth example of integrating poetry-focused digital technology within a literacy teacher education course; Bethan Marshall discusses her work of integrating multi-modalities in literacy/English education courses; and Rajeev Virmani and Peter Williamson present two case studies of classroom teachers who thoughtfully integrated digital technology into chemistry and English courses.

Section 3 considers teacher educators, who are of course key to the effectiveness of teacher education programming. Simone White and Jean Murray advocate fostering professional learning partnerships in literacy teacher education; Clare Kosnik and Pooja Dharamshi describe the goals and practices of seven literacy teacher educators who have integrated digital technology into their literacy teacher education courses; Scott Bulfin, Graham Parr, and Natalie Bellis analyze standards-based reforms and the technologizing imperative. Lin Goodwin and Crystal Chen present the findings of a large-scale survey of 258 practicing teacher educators and in-depth interviews of a purposive sample on ways their doctoral program could have better prepared them for their role as teacher educators.

Finally, Section 4 begins with an analysis of the preceding 12 chapters in terms of several key themes that emerged: intertwining digital technology with our conception of literacy; the impact of the standards movement and current political pressures; determining overall goals for education; and professional development for teacher educators. It concludes with a chapter by Clive Beck, again based largely on the earlier chapters, on future directions for teacher education.

REFERENCES


SECTION 1
DIGITAL TECHNOLOGY, LITERACY, AND TEACHER EDUCATION
1. DIGITAL TECHNOLOGIES IN TEACHER EDUCATION

From Mythologies to Making

Noted historian of technology Melvin Kranzberg (1986) once remarked that while technology is neither good nor bad, it is also not neutral. Unfortunately, the use of educational technologies in teacher education has often been framed in an inherently positive way (Selwyn, 2011), with little attention paid to how future teachers might develop a sense of technology beyond a specific device. In this chapter I will make the argument that these sorts of approaches to the use of technologies in teacher education are ubiquitous both historically (e.g., the use of Educational Television) and recently (e.g., the use of Interactive Whiteboards). The troubling history of educational reform using digital technologies will be briefly reviewed. We will then see that one of the reasons for the failure of technology to make a significant impact on teacher education is that it fails to attend to the major challenges of learning to teach. Another reason for the problematic use of technology in teacher education is the prevalence of two particular myths about the relationship between technology, learning, teaching, and learning to teach. Two models will be introduced as useful heuristics for thinking about the pieces that are typically missing when teacher candidates are engaged in learning about digital technologies. I will argue that teacher educators need to engage candidates in thinking about the history and philosophy of digital technologies so that candidates may learn about technology instead of solely focusing on mastering a particular device. A concept known as maker pedagogy, which I am currently exploring in my work, is then presented as a way of encouraging teacher candidates to understand the nature of technology. I argue that making technological things may enable teacher candidates to learn about technology.

EDUCATIONAL TECHNOLOGY: THE MYTHOLOGY OF BETTER TEACHING, FASTER

Nowadays the words educational technologies bring to mind images of tablets, interactive whiteboards, and computers. Indeed educational technology is tacitly understood by most to be synonymous with both the digital world and novel devices. It is easy to forget that the education system itself is a technology, designed in part
to produce a literate population and to pass on particular social norms. The popular press frequently tells us about the latest “must-have” gadgets and software to enable new approaches to teaching and learning, which are ostensibly more efficient, more productive, and more engaging. A plethora of apps available through Apple and Google compete for the attention of students, parents, and teachers. Whereas computers were once framed as critical tools for the modern educator of the late 20th century, the notion of taking students to a computer lab seems out-dated nowadays with the realities of carts full of iPads that can be moved from classroom to classroom. Interactive whiteboard companies seek to be as ubiquitous in classrooms as their slate predecessors.

It is always worth remembering that the concept of utopia – technological or otherwise – requires us to consider its often-overlooked definition of “no place.” The history of educational reform is grim; the history of educational reform due to technology is even less heartening. Cuban’s (1986) excellent discussion of the use of technology in education provides much-needed sobering reminders about the ubiquitous cycle of technological adoption: enthusiasm, small-scale implementation, and status quo. He reminds us that Edison once predicted that motion pictures would render teachers obsolete. Reiser’s (2001) discussion of the widespread adoption of motion pictures by the US military during the World War II for training purposes reminds us that there have been large scale uses of “training films” in educational contexts, although the trend never did catch on in schools in the ways envisioned by Edison and other technological enthusiasts.

Over the past few years, 21st century techno-enthusiasts have proudly proclaimed that Massive Open Online Courses – commonly called “MOOCs” – will “succeed” where motion pictures “failed” and take a primary role in classroom instruction, particularly at the post-secondary level. This kind of rhetoric seems to have reached its most fevered pitch between 2012 and 2014, when the death of the traditional university was proclaimed on an almost weekly basis as MOOCs created by “the best” professors would be available to all. One hears considerably less about MOOCs nowadays, perhaps in no small part due to their dismal completion rates (see Jordan, 2015, for an interesting data visualization tool). The university, and the education system at large, seems to have survived the latest unstoppable technological reform – at least for now.

Cuban’s (1986) work again demonstrates that we should not be surprised by the failure of MOOCs to encourage sweeping educational reform. In many ways, the concepts underlying MOOCs have been tried before with different media dubbed educational radio and educational television. In both cases, the idea was to tune into expertly crafted curriculum content at a particular time of day. Teachers were reduced to the ones operating the technology – literally turning the dial – and assessing how well the students understood content from distant experts. It is hard to imagine a clearer metaphor for framing teachers as deliverers of curriculum, expected to implement what they were told with little creativity or respect for craft knowledge. Neither educational radio nor educational television displaced the role of teacher in
children’s learning; the former reached its zenith in the 1940s and the latter found a
home as an on-demand supplement to a teacher’s enacted curriculum, rather than the
basis of curriculum. The ways in which educational television and films have been
used historically closely resembles the ways in which teachers in this century use
internet video sites such as YouTube to supplement their lessons – as an on-demand
media supplement to instruction, a source of ideas for teaching, and a professional
development resource for content knowledge (Szeto & Cheng, 2014). Despite a
recent proclamation that Sesame Street was the first MOOC (Kearney & Levine,
2015), educational media has never accomplished what its enthusiasts continually
suggest despite the historical precedents: Teachers have not been replaced, or even
marginalized, by educational technologies.

The Mythology of Better Teaching, Faster

It is worth taking a few moments to examine why educational technologies have
such a dismal record of educational reform. I believe there are two sets of reasons
for why this is the case, and that both are grounded in problematic mythologies.
The first and most obvious set of reasons is that the case for using technology in
education at any level is often made in economic terms. I refer to this mythology
as “better teaching, faster.” If one adopts the view that quality teaching is simply a
matter of delivering the correct content to the correct group of students in the most
efficient way possible, then it is difficult to quibble with the idea that on-demand
media offers a lucrative solution. In the age of internet video, many of us turn to
YouTube for our first stop in, say, learning how to perform a household repair or
learning what others think of a particular product we are considering purchasing.
Distance education – which for most of its existence has relied on the literal delivery
of curricular materials in the form of coursepacks, cassette tapes, or CDs – has long
made use of the human capacity to learn from media. So it is absurd to claim that
we cannot learn from educational technologies (including books, cassettes, CDs,
and internet videos), and those who argue for the widespread adoption of media in
education seem to have at least a warrant for their reasoning.

The problem is that, in my view, most of the reasons for adopting educational
technologies in widespread ways have been grounded in economic reasoning that
has little to do with enhancing the quality of students’ learning. So, technology
enthusiasts often make their case in terms of efficiency models – having the best
lessons at the ready will save both time and money in the long run, they say.
Curricular theorists have long argued that teaching is, or at least should be, far more
than transmissions of content. So although the author of a MOOC or an educational
radio program may indeed be an expert in her or his field, we have not in my view
yet reached a point where educational technologies can supplant a teacher who is
playing an active role in a classroom, reflecting a transactional or transformational
orientation to curriculum. To be clear, I am not at all suggesting that the use of
digital technologies in education is always purely for transmission purposes, nor
am I saying that fostering pedagogical relationships that are necessary for learning and using digital technologies are mutually exclusive concepts. The mythology of “better teaching, faster” has little basis in reality. There might be inherent efficiencies in having pre-designed courses ready for consumption, but basing the argument for the integration of digital technologies into education, particularly teacher education, on an efficiency model seems doomed to failure according to the lessons provided in history.

The Mythology of Theory into Practice

The second mythology that explains in part the dismal record of educational reform from digital technologies is specific to teacher education. The mythology might be summarized as: “learning to teach requires learning theories to put into practice” – a mythology that Schön (1983) argued was the basis of technical rationalism. In the context of technology and teacher education, this mythology would hold that teacher candidates need to learn the theory to use technology effectively at the academy before having a chance to “practice” in the field. Darling-Hammond (2006) did an excellent job of summarizing the three problems of learning to teach: the problem of the apprenticeship of observation, the problem of enactment, and the problem of complexity. Although the problems had appeared in the literature before, Darling-Hammond’s work was instrumental in bringing these ideas back into mainstream teacher education research. It is not difficult to extrapolate the consequences of these three problems of learning to teach to shed light on the notion of learning to teach with digital technologies. The problem of the apprenticeship of observation recognizes that future teachers have witnessed a lifetime of teacher behaviour before they enter a teacher education program. Chances are, most teacher candidates have not had an opportunity to even witness very many deep integrations of digital technologies for learning purposes in the their careers as K-12 students. We live in an era where many future teachers have not yet had the opportunity to witness, much less consider, the affordances of technologies such as mobile devices and Web 2.0 for learning – regardless of how they might use these technologies in their personal lives.

The problem of enactment is familiar to anyone who has ever taught in a teacher education program. Darling-Hammond (2006) noted that the “problem often surfaces in complaints that teacher education is too theoretical, by which teachers often mean that they have not learned about concrete tools and practices that let them put into action the ideas they have encountered” (p. 37). Teacher education programs, and those who teach within them, are often soundly criticised for failing to “prepare” teachers in ways that please their associate teachers and their future employers. Again, Darling-Hammond (2006) notes: “Learning how to think and act in ways that achieve one’s intentions is difficult, particularly if knowledge is embedded in the practice itself” (p. 37). Not only does teaching about teaching using digital technologies offer the same challenges to teaching about teaching using any
other approach or context, it also problematically relies on the availability of devices for candidates to use in the field. While blackboards are ubiquitous, tablets are not. The problem of complexity is intuitively obvious to anyone who has ever taught. As Loughran and Russell (2007) noted in their discussion of teaching as a discipline: “Teaching just looks easy, and good teaching looks even easier” (p. 218). Darling-Hammond (2006) summarized the complexity of teaching in the following way:

[Teachers] must be guided by curriculum goals that prepare students to think critically and perform at high levels, but they cannot achieve these goals by teaching a standardized curriculum. Teaching for deep understanding requires open-ended tasks and student-initiated inquiries whose course cannot be fully scripted; teachers must elicit and follow students’ thinking and manage an active learning process that goes beyond direct transmission of facts and information to the development of analytic skills and performance abilities. (p. 40)

The problem of complexity is a good way of framing why digital technologies have failed to reform education in a significant way, much less replace or minimize the need for teachers. I am unaware of any digital technologies that are able to deal with the four elements of complexity defined by Darling-Hammond (p. 39):

1. Teaching is never routine.
2. Teaching has multiple goals that must be addressed simultaneously.
3. Teaching is done in relationship to diverse groups of students.
4. Teaching requires multiple kinds of knowledge to be integrated.

Taken together, these elements go a long way to revealing why teacher candidates find it difficult to use digital technologies in their developing practice. Teaching with digital technologies can add further complications to an already complex endeavour.

MOVING FORWARD WITH DIGITAL TECHNOLOGIES IN TEACHER EDUCATION

In the previous section we have explored both the failure of educational technologies to yield significant educational reform and two relevant mythologies that contribute to that failure. In particular, we examined the problems associated with the mythology of efficiency of digital technology in education and the problems associated with the mythology of equating learning to teach with technical rationalism. In both cases, the result is often that digital technologies are framed as deus ex machina solutions to all the challenges faced by education. The slogans one often hears associated with digital technologies underscore this point: Teach all kids to code! One computer for every child! Gamify your classroom (i.e. make your teaching more closely resemble a video game). Slogans like this play into both mythologies rather handily.

All is not lost, however, despite the rather bleak tone of this chapter to this point. I actually believe that the most productive way to move forward with
digital technologies is to reframe how they are theorized within teacher education programs. One productive line of thinking is offered by the work of Desjardins, Lacasse, and Bélair (2001), who offered a competency model for thinking about digital technologies and teacher education.

Although their model was originally developed with practising teachers and later extended in Desjardins (2005), the lessons from the work of Desjardins et al. (2001) are useful heuristics for considering the way forward in the use of digital technologies in teacher education. Desjardins et al. defined four competencies that teachers require to use digital technologies:

1. A **technical** competency that enables a new teacher to use the technology (e.g., loading apps, updating software, turning it off and on, basic troubleshooting).
2. An **informational** competency that enables a new teacher to use the technology to retrieve information (e.g., web searches, twitter searches, displaying particular data in a spreadsheet program).
3. A **social** competency that enables a new teacher to use the technology to interact with other people (e.g., instant messaging, voice-over-internet protocol, discussion board posting, electronic mail).
4. An **epistemological** competency that enables a new teacher to assign tasks to digital technology to generate new knowledge or artefacts (e.g., creating formulae in a spreadsheet program, putting together a digital video, programming).

It should also be noted that the technical competency is the pre-requisite for the other competencies. I have listed the competencies in the order that they are typically pursued – it is fair to say that more teacher candidates are comfortable using technology for information retrieval than for epistemological functions.

I believe that part of the challenge of meaningfully incorporating digital technologies in teacher education is at least partially explained by the tendency of teacher education coursework – and perhaps even education more generally – to focus on the first two competencies at best. Typically, it seems as though teacher candidates are taught how to operate software and hardware within technology courses, perhaps with the end goal of creating a lesson plan that uses, say, a set of iPads with a particular app or a lesson that uses an interactive whiteboard in a particular way. Of course, there can be value in these sorts of assignments but I would argue that it is important to provide teacher candidates with experiences that help them develop their social and epistemological competencies for using digital technologies. Doing so would enable them to answer, or at least frame, foundational questions about the purposes of using digital technologies in their teaching. A consideration of social competencies would likely enable teacher candidates to think about the ways in which technology might be used to augment existing classroom discourse. Perhaps a class discussion board enables students who do not speak up in class to contribute in different ways. Perhaps individual student blogs gives teachers a unique way to tune into how their students are thinking about a particular unit of study, or classroom moment. A consideration of epistemological competencies
DIGITAL TECHNOLOGIES IN TEACHER EDUCATION

would likely enable teacher candidates to think about the ways in which digital
technologies can be used to create new knowledge or new digital artefacts. Perhaps
creating a stop-motion animation, or slowmation (Hoban, 2007) enables students
to represent their knowledge of a scientific concept in a more robust way than a
traditional test. Perhaps programming in a language like Scratch (MIT, 2015) would
allow students to develop both knowledge of programming and an appreciation for
what it takes to create a game or simulation.

The recent, pervasive enthusiasm for developing so-called “21st century skills”
argues, at least tacitly, that someone who is technologically literate knows how to use
a number of devices and programs expertly. Hodson’s (2008) concept of scientific
literacy provides a more useful orientation for thinking about what it means to be
technologically literate, particularly how to move forward with digital technologies
in teacher education. After acknowledging the often problematic nature of rhetoric
around scientific literacy, which has led to a concept that is quite challenging to pin
down, he makes the crucial point that scientific literacy needs to include learning
about science. Learning about science, for Hodson, means learning about the
history, sociology, and philosophy of science so that students leave school with
an understanding of the nature of science. Although he is quick to state that he is
not at all advocating a move away from learning science content, he does argue
that a notion of scientific literacy that solely requires all students to have some sort
of content knowledge misses the point – particularly given the dynamic nature of
science content knowledge. It is far more important, argues Hodson, for students to
learn about science so that they can judge “what counts as good science” (p. 19). He
elaborates in the following way:

While we [science educators] cannot provide all the science knowledge that
our students will need in the future (indeed, we do not know what knowledge
they will need) and while much of the science they will need to know has
yet to be discovered, we do know what knowledge, skills, and attitudes will
be essential to appraising and forming a personal opinion about the science
and technology dimensions of real world issues … Learning about science
is rather different. Gaining robust familiarity with key issues in the history,
philosophy, and sociology of science requires length and close contact with
someone already familiar with them – that is, a teacher or scientist who can
provide appropriate guidance, support, experience, and criticism. (p. 20)

For me, Hodson’s work on scientific literacy has long stood out as a beacon
in a very foggy literature that, like much of the rhetoric surrounding educational
technology, often links the pursuit of “scientific literacy” with nationalistic and
economic goals. In fact, the term was first coined by Hurd (1958), who called on
the U.S.A. to improve its citizens’ knowledge of science in the name of Cold War
superiority (and, it must be noted, in the long shadow of the U.S.S.R.’s successful
Sputnik launch a year earlier). To my knowledge, there is no literature that advocates
a similar position – the need to learn about technology – for technology education.
Perhaps this is because technology is often seen as a whimsical accompanist to science education, a spectre that shows up when necessary (Bullock, 2013).

I believe that we could take a cue from Hodson’s (2008) work as an inoculation against the two mythologies of digital technologies in teacher education (it should be noted that Hodson makes part of his case by outlining three myths about science that are present in science education). If we frame the intersection of digital technologies and teacher education as a task of learning about technology, then we might further argue that our point in teacher education is to provide candidates with experiences in which they develop an understanding of the nature of technology. In so doing, teacher candidates might be able to articulate “what counts as good technology”; the focus is less on a particular piece of software or hardware, but more on developing a set of tools to critically evaluate the potential value of a piece of technology for use in the classroom. Learning about technology requires a knowledgeable person to introduce ideas from the history, philosophy, and sociology of technology. Cuban’s (1986) work would be a good start for any exploration of the use of technology with future teachers.

Learning about technology matters in teacher education because we face the same problem as those concerned with scientific literacy. Neither teacher educators, nor teacher candidates, can hope to anticipate the technology knowledge (technical competencies) that will be required in the future. One might make a strong case that it is even more difficult to do this kind of forecasting in technology than it is in science – who would have imagined that the concept of an “app” would be in such common use 10 years ago, or that so many of us would interact with a touch screen on a daily basis. What we can do, in teacher education, is teach teacher candidates about technology so that they have some tools to navigate the technological affordances that become available over their careers.

MAKER PEDAGOGY AND TEACHER EDUCATION

The maker movement is both a new and an old phenomenon. Simply put, the maker movement is a loose collection of people with shared interests in making things. Typically, self-identified members of the maker movement focus on making things that use electrical technologies – typical projects include repurposing old computers, building small robots, and designing custom parts for large-scale electrical projects. In its most recent iteration, the maker movement has developed a bit of a business venture in addition to the looser collective interpretation in the zeitgeist. Initiatives such as Maker Fairs, Make Magazine, and the proliferation of pre-fabricated maker kits for things like drone aircraft, robotics, and circuit projects reflect both the desire to obtain certain kinds of electrical and technological parts and circuits and the ability of entrepreneurs to cater to increasing interest. Noted, self-identified maker Chris Anderson (2012) argues that one of the big shifts toward the recent trend in maker culture was the ability to manufacture prototype designs of technological artefacts in one’s own home due to relatively inexpensive new
tools such as laser cutters and 3D printers – previously unavailable outside the manufacturing sector.

Of course, humans have made things since as long as we have been human. Some characterize the current maker movement as an extension of the Arts and Crafts movement of the late Victorian Era. The arts and crafts movement sought to connect art with labour in ways that valued individual creations and reacted against the rampant consequences of the industrial revolution (Triggs, 2009). Crawford (1997) emphasized the importance of finding “joy in labour” to the Arts and Crafts movement, stating:

This joy in work, this creative freedom, was equated with handwork by the Arts and Crafts movement, and we can see the impact of this idea on Arts and Crafts objects whose appearance declares that they are handmade – the hammer marks on metalwork, the fluid, irregular contours of some pottery and glass, and the marks of the adze or chisel on wood or stone. (p. 18)

Krugh (2014) builds on Crawford’s ideas to argue that craft has been politicized since the Arts and Craft movement. In particular, Krugh believes that “The social concerns over exploitative labour practices, international competition, and poor design quality influenced the Arts and Crafts movement reformers to link labour and art” (p. 285). These concerns led some members of the movement to form guilds modelled on the medieval craft guild. One can certainly link the interest in reclaiming craft through the value of individual labour and local expertise in the Arts and Crafts movement and the current fascination with making electronic and “technological” things. Just as the Arts and Crafts movement sought to reclaim individual craftwork from industry, so too does the maker movement seek to encourage others to make items that seem to be only within the purview of large technological companies. The Arts and Crafts movement encouraged its members to meet in guilds to share knowledge and develop a shared identity. The maker movement encourages its members to meet in maker spaces for similar reasons.

Despite the increasing visible presence of the maker movement in popular culture (Thompson, 2013), there is still little academic literature on the topic. One exception is Honey and Kanter’s (2013) edited book-length discussion of links between the conception of what they call the maker sensibility, and “deep engagement with content, experimentation, exploration, problem-solving, collaboration, and learning to learn” (p. 4). They capture some elements of the maker movement in an approach to learning science which they characterize as design, make, and play. Crawford (2006) provides a far more philosophically rigorous argument against the tendency to separate thinking from doing and thus privilege universal propositional knowledge over contextual, embodied knowledge “in the making.” He reminds us that: “creativity is the by-product of mastery of the sort that is cultivated through long practice” (p. 51) before concluding that accepting thinking as doing requires educationists to reposition knowledge, often tacit, developed through tangible experiences. There is a clear reallocation here of the privileges of supposed universal
knowledge in teaching (so-called best practices) and the situated, contextual kinds of knowledge encountered in everyday practice.

Mindful of the arguments put forth in Desjardins et al. (2001) and Hodson (2008), I have drawn from ideas prevalent in the maker movement to posit that a productive way forward in digital technologies and teacher education is something that I refer to as maker pedagogy. Simply put, I define maker pedagogy as an approach to teacher education that engages candidates in making technological things – circuits, simple robots, video games and simulations, and re-cycled artefacts according to the following four principles:

1. **Ethical hacking**: Deconstructing existing technology for the purpose of creating knowledge (e.g., taking an old computer apart to learn about hardware, and applying that knowledge to work with small hobby computer kits such as Raspberry Pi).
2. **Adapting**: Using technology for purposes other than what was originally intended (e.g., using an old smartphone to learn elements of computer programming).
3. **Designing**: Selecting and using technological artefacts and ideas to solve problems (e.g., using conductive tape, batteries, and LEDs to design decorative circuits that can be integrated into clothing).
4. **Creating**: Archiving contextual knowledge obtained through engaging in the process of making (e.g., creating a wiki that documents how particular projects were accomplished) and, of course, enjoying the actual tangible products that come from making (e.g., playing a video game that was designed within a maker space).

In my current project, I have invited participants to have the opportunity to construct and extend professional knowledge about teaching science by building technological artifacts in a lab called a *Maker Space* created in their teacher education program. Among other things, I hope participants are learning more about fields such as robotics, engineering, applied physics, and computer programming and considering the ways in which these fields might play a role in their pedagogy. Our Maker Space is an *ad hoc* place where participants come together, at pre-arranged times, in a classroom to work through technological projects designed to introduce them to maker pedagogy. Our projects thus far include making electric circuits out of paper (adapting, creating, designing), programming simple video games (designing, creating), making stop-motion animations to explain scientific concepts (designing, creating), and repurposing old t-shirts to make shopping bags with electronic lights for decorative purposes (adapting, designing, creating). Future projects will address the *ethical hacking* principle by providing teacher candidates with the space to deconstruct common technological devices such as old computers and smart phones.

The maker pedagogy project is still in its early stages, so I have no data to report at the time of writing this chapter. What I have tried to do in this section, however, is make a case for the value of maker pedagogy in addressing my previously stated beliefs that *learning about technology* is important for teacher education, and that
the Desjardins et al. (2001) competency model provides an heuristic for thinking about the kinds of things teacher candidates should know and be able to do with technology. Engaging in making technological things may well enable teacher candidates to learn about the nature of technology, and develop what Munby and Russell (1994) referred to as authority of experience over their work with technology. In addition to developing technical competency through these projects, it is my hope that experiences with maker pedagogy will enable teacher candidates to develop informational, social, and epistemological competencies around the use of technology in their teaching. Maker projects rarely unfold exactly according to instructions, so an informational competency is required to search for ideas that can help a maker teacher work through a problematic project. Our maker space is social and relies heavily on communication between participants – a social competency is required to keep these conversations going outside the maker space through technology. Finally, projects such as video games and simulation design encourage teacher candidates to develop epistemic competencies. I am optimistic about the potential of maker pedagogy to make a contribution to research on digital technologies and teacher education.

CONCLUSIONS AND CAUTIONS

In this chapter I have argued that further repetition of the grim history of technology and teacher education can potentially be avoided through a robust consideration of the implications of the Desjardins et al. (2001) competency model and, drawing from Hodson’s (2008) work on scientific literacy, through a conceptualization of technology teacher education that involves learning about technology. I argued that learning about technology requires teacher candidates not only to consider the history and philosophy of technology, but also to have actual experiences of considering technologies in ways that go beyond developing technical and informational competencies. I believe that teacher educators are not well prepared to forecast the kinds of technical competencies that will be most useful for new teachers throughout their careers. It is more important for new teachers to – again to paraphrase Hodson (2008) – develop skills of recognizing useful technology for pedagogical purposes. The development of social and epistemological competencies with respect to technology in teacher education seems like a worthy goal for teacher educators, one that will hopefully help future teachers problematize the idea that using technology for teaching is automatically justified from efficiency perspectives.

The maker movement is receiving increasing attention in popular culture and bears some resemblance to the Arts and Crafts movement of the late Victorian Era. There are at least two unifying features to both movements: Both rejected mass production in favour of emphasizing individual skill and an orientation toward “do-it-yourself”, and both encourage people to make things (craft) in small groups to share skills and build identity. Significantly, the maker movement of the 21st century is encouraging people to experiment with electronics, computers, and robotics in
ways that were previously unimaginable or inaccessible. I believe that the maker movement, with its emphasis on creating technological artefacts and producing electronic prototypes on demand has several features that could be valuable to future teachers. I define maker pedagogy as an orientation to learning about teaching with technology that emphasizes making technological things in small groups. The ability to design and create new technological items stems from a willingness to learn about how existing technologies work and adapt them for atypical purposes.

My work with maker pedagogy is in development and I am particularly aware of cautions made by Neil Selwyn regarding research in educational technology. In particular, Selwyn (2011) leads me to wonder whether my investigation of maker pedagogy might fall under his concern that educational technology is “an essentially positive project” (p. 713). I shall try to avoid falling prey to the kind of uncritical positivity about maker pedagogy by focusing on the interplay between education, technology, and society (Selwyn, 2011). I think that drawing from the culture of making beyond schools and, critically, taking a historical view of how these ideas have developed in the last century from the Arts and Crafts movement, is a step in the right direction. Similarly, Selwyn’s (2012) ten suggestions for improving academic research in the field serve as useful guideposts in the somewhat tumultuous waters of maker pedagogy. Like most research in education and technology, the maker movement has its share of evangelists who seek to convert others to the belief that making will solve the problems of K-12 schooling. I make no such claim. However, I do believe that making might encourage teachers to learn about technology in a way that gives insight into the nature of technology, in ways that device-focused technological education does not. I have tried to be mindful of certain suggestions made in Selwyn (2012), namely: “maintains a sense of history” (the Arts and Crafts movement), “has nothing to sell” (I pick maker projects that are not linked to certain companies, are device agnostic, and, are ideally, open-sourced), and “makes good use of theory when and where it is helpful” (p. 214).

Going forward, I believe that my work in maker pedagogy will need to pay particular attention to Selwyn’s (2012) encouragement to engage “with the politics of education and technology” (p. 214) and be “rigorous and appropriate when it comes to methods” (p. 214). Currently, I am using ethnography and collaborative self-study to investigate maker pedagogy with my participants. I think about the politics of making; indeed many of my participants have said they were drawn to the idea of making out of weariness with the consumerism that is rampant in today’s culture, particularly around acquiring the latest technological wonder. Maker pedagogy seems as though it has potential to help people learn about technology, particularly if they are asked to take apart existing devices with the intent of adapting them for new, unanticipated purposes.

Technology is a quintessentially human invention that occurred long before tablets, computers, and smartphones. Indeed, our use of technology is part of what makes us human and so it is strange to minimize the role that technology might play in learning to teach, or in the development of future teachers’ pedagogies. But we
need to move beyond learning how to use particular devices that come pre-packaged with defined uses and programs. Technological literacy requires us to know about the nature of our devices, not just how to use them. It requires us to be able to dream of unanticipated possibilities. We in teacher education need to find a way to move beyond the mythology to learn about the nature of technology. Maker pedagogy is a potentially productive way forward.

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