Journal of Technical Education

Band 1, 2013, Heft 1

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Herausgeber

Bernd Zinn

Ralf Tenberg

Journal of Technical Education (JOTED)

ISSN 2198-0306

Online unter: http://www.journal-of-technical-education.de

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Abstract

This paper explores the challenges associated with helping future science teachers to develop professional knowledge of how to teach using digital technologies. First some of the salient literature on science teachers' professional knowledge is reviewed. Extending the dominant concept of PCK to the realm of knowledge about technology is argued to be inherently problematic. Then a theoretical framework, grounded in professional competencies, is presented that seems to be a more useful way to think about how future science teachers learn to teach using technology. Self-study methodologies are then offered as a way for documenting and analyzing one's own practice, before making a final case for more research that explicitly explores connections between frameworks from research in educational technology and the self-study of teacher education practices.

Keywords: professional knowledge of science teachers, self-study methodology, competency model, technology and teacher education

„Making the Tacit Explicit": Ein Selbststudium und die Vielfalt des Technikunterrichts

Zusammenfassung

In diesem Artikel werden Aufgabenstellungen untersucht, die damit assoziiert werden, dass sie zukünftigen Lehrern der Naturwissenschaften beim Aufbau von beruflichem Fachwissen helfen können, wie man mit Hilfe digitaler Technologien unterrichten kann. Zuerst informierte sich der Autor in einigen der vorliegenden Fachbücher zum Thema „Berufsbezogenes Wissen für Lehrer der Naturwissenschaften". Diese vertraten die These, dass der Ausbau des zumeist verwendeten „Konzepts des persönlichen Wissenserwerbs" aufgrund des Wissensspektrums im Fachgebiet Technik von Grund auf problematisch sei. Dann wurde eine Theorie präsentiert, die auf den berufsbezogenen Kompetenzen basierte; dies scheint ein eher gangbarer Weg zu sein, wie zukünftige Lehrer der naturwissenschaftlichen Fachrichtungen das Unterrichten mit dem Einsatz von Technik erlernen können. Die Methodik des Selbststudiums bietet sich dafür an, die eigene Berufspraxis zu dokumentieren und zu analysieren, bevor man ein finales Plädoyer für eine intensivere Forschungsarbeit abgibt, die die „Verbindungen zwischen Wissenschaftstheorie, der im Unterricht verwendeten Technologie und dem Selbststudium der Lehrerunterrichtspraxis" erforscht.

Schlüsselwörter: Fachwissen der Lehrkräfte für Naturwissenschaften, Methode für das Selbststudium, Kompetenzmodell, Technologie- und Lehrerbildung

The Role of Technology in the Professional Knowledge of Science Teachers

> "I am a teacher who teaches teachers. When I use that description to introduce myself, it always seems awkward, highlighting the complexity, the ambiguity, and the apparent contradictions of the enterprise of teacher education" (Russell, 1997, p. 32)

Russell's comments about teachers' education have always rung true with me, perhaps, because of the hybrid space that science education – and thus science teacher education – occupies within the academy. I am a science education professor in a Faculty of Education with an academic background in physics, in history and philosophy of science and technology, and in science education. I have taught science at the K-12 level and at the college level, and I have spent a considerable amount of time in my academic career working with future science teachers in teacher education programs. I exist in multiple academic spaces by presenting research at conferences devoted to education research, geophysics, and the history of science, each of which has a distinct vocabulary and set of cultural norms.

This necessity of existing in a hybrid space was signalled by the work of Shulman (1986), who introduced the idea that teachers develop so-called *pedagogical content knowledge* within their respective disciplines. The concept names the intuitive sense teachers require something beyond both knowledge of subject matter and a general knowledge of pedagogy: Teachers need to know how to meaningfully combine these two domains of knowledge to develop knowledge of teaching particular content in developmentally and pedagogically appropriate ways. The concept of pedagogical content knowledge (PCK) has stimulated a considerable amount of thinking and research in science education research since its inception, although there seems to be little agreement as to the specific epistemology of PCK, or how to document and analyse the development of PCK in science teachers. I am unsure if PCK will ever be anything more than an heuristic that some researchers find useful for interpreting the unique nature of teachers' professional knowledge; I am personally more interested in articulations of professional knowledge that draw from seminal work on experiential learning by Schön (1983, 1987).

The hybrid space is made even more complicated by the modification to PCK made by Mishra and Koehler (2006). In their highly cited paper, the authors introduce the concept of technological pedagogical content knowledge, often referred to as TPCK or the "TPACK" (technology, pedagogy, and content knowledge) model (Thompson & Mishra, 2008). Mishra and Koehler (2006) acknowledged the incoherence in the literature on PCK, they nonetheless believed the construct to be an appropriate starting point for their work stating, "It is valued as an epistemological concept that usefully blends the traditionally separated knowledge bases of content and pedagogy" (p. 1022). They further justified their use of PCK by arguing:

> "What is interesting is that current discussions of the role of technology knowledge seem to share many of the same problems that Shulman identified back in the 1980s. For instance, prior to Shulman's seminal work on PCK, knowledge of content and pedagogy were considered separate and independent from each other. Similarly, today, knowledge of technology is often considered to be separate from knowledge of pedagogy and content." (p. 1024).

Unsurprisingly, Mishra and Koehler (2006) then go on to present a Venn diagram composed of three circles: one representing content knowledge, one for pedagogical knowledge, and one for technological knowledge (p. 1025). The union of all three circles is argued to represent the space, where *technological pedagogical content knowledge* (TPCK) exists. The reader is left to work out the three permutations of intersections between two of the three circles. It is worthwhile to quote Mishra and Koehler's articulation of TPCK at some length:

> „Technological pedagogical content knowledge (TPCK) is an emergent form of knowledge that goes beyond all three components (content, pedagogy, and technology). This knowledge is different from knowledge of a disciplinary or technology expert and also from the general pedagogical knowledge, shared by teachers across disciplines. TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones." (p. 1028-1029).

The idea here is that knowledge of how to use technology alone does not enable someone to provide meaningful learning experiences using technology. The argument is purposefully aligned with Shulman's (1986) argument about the emergent quality of combining knowledge of content with knowledge of pedagogy, stated earlier.

Like PCK, TPCK is quite an appealing concept for many. It seems to make intuitive sense that knowledge of technology, pedagogy, and subject matter are, by themselves, insufficient to ways of understanding the complex work of technology educators. Like PCK, however, TPCK is both a highly researched and hotly contested model (See Berry, Loughran, & van Driel, 2008 for a discussion of some of the issues around PCK). Graham (2011) argued that TPACK had "the potential, to provide a strong foundation for future technology integration research" and could "provide theoretical guidance for how teacher education programs might approach training candidates who can use technology in content-specific as well as general ways" (p. 1959). I take exception to the idea of reducing teacher education to "training," but Graham does highlight one key difficulty that many researchers have with the TPACK framework: the fact that it is more descriptive than predictive. Voogt, Fisser, Roblin, Tondeur and van Braak's (2012) literature review confirms that there is "no agreement on what TPACK is" but continues to argue that TPCK is "a knowledge base" that requires further articulation (p. 119). Voogt et al. are particularly concerned about developing the TPCK knowledge base for "specific subject domains" (p. 120), perhaps using Delphi studies, and conclude by stating: "there is a need for valid and reliable instruments, where a teacher can demonstrate TPACK" (p. 120). Indeed, a recent literature by Wu (2013) highlights the significant rise in papers devoted to exploring the implications of the TPACK framework, a trend that is likely to continue in the immediate future.

My purpose in introducing PCK and TPCK is not to devote more space to unpacking the arguments for and against these frameworks for knowledge of teaching and learning. Instead I called upon these frameworks as a way of introducing the inherent contested hybridity of science and technology education. Regardless of whether one agrees or disagrees with the conceptual foundations of PCK and TPCK, their inherent appeal to many underscores the multi-faceted nature of work in science and technology education.

I have taken to referring to the role of technology in science education as a *spectre*, particularly given recent initiatives in so-called STEM (Science, Technology, Engineering, and Mathematics). A spectre is often defined as a ghostly apparition, which often brings with it feelings of unease. Despite being an enthusiastic user of technology in my personal and professional life, I am often concerned about the connection between science and technology education. Technology often seems to be an afterthought to science education, as though technology education will automatically occur concurrently and/or subsequently to experiences in science education.

In Canada, education is a provincial, rather than a federal responsibility. In the province of British Columbia, where I currently teach and work, technology is inextricably linked with science education at the curricular level in both elementary and secondary contexts (see, for example, BCME, 2005). The most recent curriculum documents discuss integration between science, technology, society and the environment (STSE) in broad terms. Technology is frequently featured as an example of the application of scientific concepts to particular concepts and, for this reason, seems to often be positioned after more fundamental concepts are learned in the science curriculum. One notable exception exists at the secondary level – an optional grade 11 course entitled "science and technology" enables teachers to select two topics from the science module and two from the technology module. The technology module offers the study of computers and communication, home and technology, personal technologies, space exploration, and transportation technology as options. To my knowledge, this is the only place in the current provincial curriculum that offers a study of technology as a discipline in its own right.

Perhaps another reason that the concept of technology is somewhat elusive in science education has to do with the confusion around the term *technology* itself, at least in the English language. Marx (2010) provided a useful summary of the development of the term technology in English. He states that the Greek root *techne* (as in an art or craft) was combined with *ology* (the study of something) in the English language in the 17th century. It is important to note that technology, in its original sense, referred to literally the *study* of mechanical arts as opposed to the arts themselves (cf. Schatzberg, 2006). Nowadays, when we use the word "technology" in the English language, we usually mean a device, system, or mechanical art. We do not mean the study of a particular mechanical art. Marx's key point is that *technology* was redefined in the English language as a way of describing certain cultural developments in the early 20th-century:

> „My assumption is that those changes [i.e. the rapid development of machines and other consequences of the industrial revolutions], whatever they were, created a semantic-indeed, a conceptual-void, which is to say, an awareness of certain novel

> developments in society and culture for which no adequate name had yet become available. It was this void, presumably, that the word technology, in its new and extended meaning, eventually would fill. It would prove to be preferable - a more apt signifier - for the new agents of change than any of its precursors, received terms such as the mechanic (or useful or practical or industrial) arts, or invention, improvement, machine, machinery, or mechanism." (Marx, 2010, p. 563).

Marx argues that products of the late 19th-century and early 20th-century, such as the electric light, the radio, and the telephone, were particularly important in developing the current use of the word technology in the English language.

It is against this messy backdrop of confusion over what counts as knowledge of teaching technology and confusion over the very meaning of the term, that I need to situate myself as a an education professor, a researcher and a teacher of teachers. Selwyn (2011) captured the academic tension well, when he referred to research on educational technology as an "essentially 'positive project'" before going on to say that "most people working in this area, are driven by an underlying belief that digital technologies are – in some way – capable of improving education" (p. 713). I share Selwyn's concerns and I admit that I think digital technologies have much to offer education at all levels. But I also takes Selwyn's later point, made in the same article, that it is important to develop a kind of productive pessimism that, in part requires "reorienting the educational technology mindset so that it is accepting the social world as it is and is comfortable in its inability to offer definite technological answers to what are indefinite problems" (p. 717). In this way, I situate my research in technological education within my teacher education classrooms, rather than trying to solve of the problems and challenges of science teacher education by metaphorically throwing technology at them. This approach has at least three consequences:

1. I need to explicitly define what technology can do so that I can avoid the temptation to over-reach in my research by assigning technological solutions to "indefinite" problems.
2. I need to adopt a theoretical framework that helps me to design, interpret, and analyze my research into the role of technology in the professional knowledge of science educators.
3. I need to use a rigorous research methodology to investigate my *own* practice as a "teacher of future science teachers".

The purpose of this paper is to situate the author's research in the use of technology in science teacher education in what Selwyn (2011) would refer to as "'around the edges' of educational settings" (p. 717). I do not claim that any of this research can or should stimulate large scale reform in science education. Such reform is not my goal; I far prefer to offer my work as a stimulus for other science and technology educators, in the hopes that others might analyse carefully their particular edges of education. First I will discuss a theoretical framework that has been a productive way for me to think about the role of technology in education. Second, I will briefly outline a research methodology, known as self-study of teacher education practices (S-STEP) that provides a way for making warranted claims about one's own practices. Finally, I present some examples of the ways in which I have used technology in my science teacher education courses over the past few years, making links to the aforementioned theoretical framework. The paper then concludes with comments on how his recent work has helped him to make sense of the complexity of the role of technology in the professional knowledge of future science teachers.

Theoretical Framework

The ways in which I think about the use of technology in education, has been greatly influenced by the work of Desjardins, Lacasse, and Bélair (2001) and Desjardins (2005). Their work is particularly powerful because they provide both a model for understanding how we use technology and research data that supports their theoretical construct. This is in sharp contrast to a rather disturbing feature of some work in educational technology: the tendency to introduce terms that have little to no epistemic value, but that catch fire in the popular imagination. Prensky's (2001) contrast between "digital natives" and "digital immigrants" is one striking example of this problem. His central point was that students, who have grown up with certain technologies, have new skills, that "are almost totally foreign to the Immigrants, who themselves learned – and so choose to teach – slowly, step-by-step, one thing at a time, individually, and above all seriously" (p. 4). Thus, those of a certain age are luddites, who need to radically reorient their thinking to keep up with a younger generation; the education system needs to be radically reformed to accommodate the "new" learning. Putting aside, for a moment, the unhelpful rhetoric in the article that makes it difficult to read, we also find that the concept of digital natives is not supported by research evidence. A review by Bennett, Maton, and Kervin (2008) in the *British Journal of Educational Technology* found:

> „The picture beginning to emerge from research on young people's relationships with technology is much more complex than the digital native characterisation suggests. While technology is embedded in their lives, young people's use and skills are not uniform. There is no evidence of widespread and universal disaffection, or of a distinctly different learning style the like of which has never been seen before. We may live in a highly technologised world, but it is conceivable that it has become so through evolution, rather than revolution. Young people may do things differently, but there are no grounds to consider them alien to us. Education may be under challenge to change, but it is not clear that it is being rejected." (p. 784).

In contrast, the Human-Computer-Human Interaction (HCHI) competency model, developed originally by Desjardins, Lacasse, and Bélair (2001), has strong epistemic legs on which to stand. Desjardins et al. began developing a competency model by consulting lists that articulated some vision of what teachers should know and be able to do with computers. They found items, such as performance indicators or desirable standards, from organizations, such as International Society for Technology in Education (ISTE), Industry Canada, and the Ontario Ministry of Education. After tabulating the items, they decided that a competency is "described as a combination of elements of knowledge that can be called on to identify and act upon a specific task or problem" (p. 213). The defined four different orders of competencies, as follows:

> *Technical Order (T)*: The competencies required to use digital technologies; this order treats the technological artifact itself as a site of investigation: "the array of conceptual and procedural knowledge usually constructed, when experimenting with computers, then applied as useful methods to operate ICT tools efficiently" (p. 214).
>
> *Informational Order (I)*: The competencies required to use digital technologies to access, store, filter, and aggregate information: "the array of conceptual and procedural knowledge usually constructed while searching for specific information using a variety of databases or search engines, in order to extract useful procedures for identifying, selecting, classifying and coherent grouping of data." (p. 214)
>
> *Social Order (S)*: The competencies required to interact with each other through digital technologies, such as email, instant messaging, VOIP, and various social media: "the array of mostly procedural knowledge usually constructed, while reflecting on communication experiences, where a concern for the needs of others emerges, thus establishing a viable way of thinking and acting with other individuals or groups." (p. 214)
>
> *Epistemological Order (E)*: The competencies required to use digital technologies to process information in novel ways, such as the ability to program a spreadsheet to process data: "the array of conceptual knowledge, usually constructed by reflecting on and anticipating what the technology can do, to draw analogies, connections, operational schemes and methods to be used in problem solving tasks." (p. 214)

Crucially, Desjardins et al. (2001) also conducted research designed to test, whether or not these orders were, in fact, independent from each other. They developed a 30-item questionnaire with phrases beginning with "I able to…" and ending with a statement corresponding to one of the competencies. The list was then sent to six expert judges; when four of the judges believed an item to be representative of the same competency, the item was retained. The final 22-item questionnaire was then sent to 19 teachers. The authors concluded that "the results effectively discriminate between the four orders of competency as stated: technical, informational, social, and epistemological . . . [and] the corroboration from 6 judges ensures sufficient validity for the instrument" (p. 216).

In an important follow-up, Desjardins (2005) used a modified version of the instrument with a larger sample (N=225) of secondary school teachers. Five items were included for each competency, for a total of 20 items. The Cronbach α coefficient for each order of competency was ≥ 0.81, a good internal consistency. In this same article, Desjardins attempted to develop competency profiles using the sum of scores participants gave themselves for each item in each competency. He found that male participants tended to give themselves higher scores in both the technical and the social orders; but that there was no difference between men and women self-assessed scores for the informational and epistemological orders. Not surprisingly, those, who reported that they used computers more also rated themselves more highly in terms of competency in all orders. The following comments highlight some of the other interesting conclusions of this work:

- Participants rated themselves most highly on the informational order and least highly on the epistemological order, meaning that the teachers who participated in this study were least likely to use what Jonassen (1996) referred to as mindtools to solve technological problems.
- Participants, who had significant experiences in other workplaces, were more likely to rate themselves highly on the epistemological order than participants who had entered the school system directly.

In my view, the model articulated in Desjardins et al. (2001) and Desjardins (2005) provides a useful framework from which to examine and analyze the ways in which digital technologies have been used in my science and technology teacher education courses. I have not, however, used the questionnaire to survey candidates in my courses in order to develop competency profiles. That kind of work would likely be useful on a larger scale. Instead, I combine self-study methodology with the theoretical framework described by Desjardins and colleagues as a way of thinking about opportunities, gaps, and challenges in what Loughran (2006) would call my pedagogy of teacher education.

Self-Study of Teacher Education Practices

The methodology of self-study of teacher education practices grew out of a session in the early 1990s at the annual meeting of the American Educational Research Association (AERA) to become one of the largest special interest groups (SIGs) in AERA, with members from many different countries all over the world. A complete history of this methodology is outside the scope of this paper, but one important catalyst for self-study was the emphasis on reflective practice in the professions that Schön (1983, 1987) drew attention to in his seminal work on professional knowledge. Over the last few decades – for better and for worse – teacher candidates have been asked to "reflect" on their practice (in host schools) because theorists, such as Schön and Dewey (1933), remind us that it is difficult to learn from experiences without having an opportunity to critically analyze those same experiences. Reflection has become a loaded term in teacher education, and in the education of many other professionals, in part because of its nebulous nature. As Russell (2005) provocatively asked: Can reflective practice be taught?

At least a part of the answer to that question seems to be found in the notion of "modeling," which involves education professors enacting pedagogies in ways that they hope teacher candidates in their classes will consider for their work in the K-12 school system. Loughran (2004) offers a useful summary of the role of modeling in self-study:

> „'Practicing what you preach' has long been recognized as a powerful teacher as students learn much more from what a teacher does than what a teacher says. Therefore, teaching student-teachers using the methods and approaches that they themselves are encouraged to use in their own teaching matters – a lecture on co-

> operative group work does not necessarily offer great insights to teaching or learning through group work. Modeling through self-study may then entail involving students and sharing the steps of the investigation with them as well as illustrating how the classroom is a site for reflection and inquiry. However, the term modeling can create difficulties for it is easily misconstrued as, in some cases, it is viewed as a synonym for mimicry, or the creation of a model or template for easy replication.“ (p. 11).

One important goal of self-study methodology is to examine the extent to which one’s practice is enacted in the ways it is intended. In other words, to what extent do I, as an education professor, “practice what I preach” when it comes to the role of digital technologies in education? As Loughran (2004) noted, “the interplay between teaching and learning becomes more accessible and valuable as this purpose of self-study (modeling) creates ongoing experiences that offer opportunities for both teachers and students to experience meaningful learning for themselves” (p. 13).

Self-study is a methodology focused on improving one’s own practice and generating knowledge about how to teach teachers. It uses a variety of (usually) qualitative methods, such as analysis of research journals and teaching artifacts, participant observation, and semi-structured interviews. The word “self” in self-study does not necessarily imply a solitary pursuit, however. Many self-study researchers have employed, what Costa and Kallick (1993) refer to as a *critical friend* to help them to challenge, analyze, and interpret their work (e.g., Nilsson & Loughran, 2012; Schuck & Russell, 2005). Tidwell and Fitzgerald (2004) argued that a critical friend is “instrumental to the rigor and validity of self-study” (p. 70). Although self-study researchers are quick to point out that there is no consensus on the “one way” to conduct a self-study into practice (Loughran 2004; 2005), they do argue that there is a particular coherence to the methodology governed largely by qualities of self-study articulated by LaBoskey (2004):

> „The research is *improvement-aimed*; we wish to transform ourselves first so that we might be better situated to help transform our students, their students, and the institutional and social contexts that surround and constrain us. In order to guard against the inevitable limitations of individual interpretation so affected by personal history, self-study is *interactive* at one or more stages of the process. Since the aim is greater understanding rather than immutable law, the methods of self-study are largely qualitative; but they are *multiple* … We advance the field through the *construction, testing, sharing, and re-testing of exemplars of teaching practice*.“ (pp. 820-821)

Self-study has driven my pedagogical and research work in science education and, increasingly, in technology education, throughout my academic career. I find the concept of an intersection between my responsibilities to research and teaching appealing because, as an education professor, I feel particular responsibility to develop research-based warrants for my enacted pedagogy. In that spirit, I now turn to the final section of this paper, which presents some results of an ongoing self-study into the role of technology into his pedagogy of science teacher education.

Conclusion: Making the Spectre of Technology Explicit

This paper began with the suggestion that technology education often seems to be a spectre, a ghostly apparition, within the larger realm of STEM initiatives. Future science teachers are often interested in (and sometimes feel obligated to) meaningfully incorporating digital technologies into their practice. Like most other technology educators, I believe that there has to be a purpose, beyond what one might call the “wow” factor, to using technology in any classroom.

Self-study methodology offers some promise because it seeks to make the tacit explicit. It challenges academics with an interest in using technology in their classrooms to discuss not only *what* they did, but *why* they enacted a particular pedagogy and, importantly, what they might do differently next time to support the quality of students’ learning. A recent series of books published by Springer press (e.g., Crowe, 2010; Bullock & Russell, 2012; Schuck & Pereira, 2011) has explored the intersections between self-study methodology and other domains of discipline-based educational research, such as social studies, science, and mathematics. I believe that self-study methodology has considerable potential to interact with the literature on technology education, with positive benefits for both sets of literature.

Hoban (2004) did offer some comments about the potential intersections between research in digital technologies and self-study of teacher education. The focus of his chapter, however, was on using technology to support research in self-study of teacher education practices. He argued that technology offered considerable support for two critical elements of self-study methodology: “*representing* teaching experiences in many different forms” (p. 1045) and “*sharing* personal insights with others and *accessing* public theory” and providing “*flexibility* for when, where, and with whom this sharing occurs” (p. 1046). Hoban then went on to provide a case study of how self-study could be supported through digital technologies, citing the relevance of e-mail, multimedia, and the World Wide Web for self-study research.

Of course, the references to particular technologies seem somewhat dated given the proliferation of current digital technologies, but the lessons remain sound. Hoban offered the following comments that should ring true to the current technological landscape:

> *Email*: “Email helped the researchers to represent their experiences which they accessed when needed but more importantly helped them to reflect and sustain the sharing of ideas and feelings that is fundamental to knowledge construction” (p. 1050).
>
> *Multimedia*: “Not only can a CD-ROM store a variety of digital data – pictorial, text, and sound – but it can also provide multiple methods for accessing the data depending on its structure. For example, text can be read, video clips viewed, sound listened to, or a combination of media used together” (p. 1056).
>
> *World Wide Web*: A website designed as a database for teacher candidates demonstrated “how preservice teachers can present different interpretations of being in the same class and highlights the ‘‘living contradiction’’ (Whitehead, 1993) of teaching, as students interpreted the same class in different ways. As such, the data presented the researcher with dilemmas and contradictions in his teaching.” (p. 1057).

It is not difficult to extend these arguments to current digital technologies. Email is still widely in use, but some self-study researchers (e.g., Bullock, 2013a) have explored the use of blogs for reasons similar to those articulated by Hoban. Multimedia has become exponentially easier to create and to share, many people carry personal video cameras in the form of smartphones every day. McKnight, Hoban, and Nielson’s (2011) recent work on *slowmation* has demonstrated the power of engaging science teacher candidates in the production of short, animated stop-motion videos that represent content knowledge. Finally, the ease of publishing online through platforms such as Wordpress, Blogger, Wikimedia, and Tumblr have freed both teacher educators and teacher candidates up to co-create online repositories and portfolios.

Although I agree that digital technologies can support self-study methodology, he is arguing in this paper for more of the kind of work done by Hoban (2008), Bullock (2013a) and Bullock (2013b) use self-study as a vehicle for exploring digital technologies, rather than the other way around. For example, in Bullock (2013b), I explored the potential utility of asking teacher candidates to design and implement a self-directed learning project, in which they taught themselves how to use a particular technology for pedagogical purposes. The candidates were also instructed to create a short video clip, articulating what they learned from the experiences. When they presented these videos at the end of the course, I noted in my research journal that there was very little evidence that many candidates had moved beyond the idea of mastering, how to use a particular piece of software or hardware. In Bullock (2013a), I explored the use of blogs to tune into experiences that teacher candidates were having during their field experience placements. I argued that blogs allowed me to continue building on the relationship developed with students throughout the course.

If I were to apply the Desjardins et al. (2001) model to this work, I could argue that much of my past efforts in using technology in science education classes have been focused on developing technical and informational competencies. One might argue that creating short video clips in Bullock (2013b) was a form of epistemological competency, because new knowledge was created in the video format, or that blogging with students in Bullock (2013a) was a form of social competency, because of the communication patterns that needed to be established. But I admit that these links are tenuous and need to be explored with much more rigour, perhaps through self-studies designed to explicitly examine the development of social and epistemological competencies in science teacher education.

I began this paper by reviewing some of the recent thinking around the nature of science teachers’ professional knowledge and argued that the construct of technological pedagogical content knowledge was unlikely to get us very far, in part due to the questionable value of the construct of PCK and the slippery slope of defining technology. I then argued that the four competencies model offered by Desjardins et al. (2001) and Desjardins (2005), offered a more rigorous framework for thinking about the use of technologies in science teacher education. Self-study methodology was then presented as a way for researchers to investigate carefully the features of their own pedagogies with a view toward critical analysis through critical friendship. Finally, I interpreted work at the intersection of self-study and digital technology and encouraged the use of self-study in exploring the challenges and opportunities of digital technologies in science teacher education.

The road ahead is both difficult and exciting for researchers in technology education. Opportunities abound as devices become more ubiquitous and teacher candidates come to the already existing courses, expecting to explore the pedagogical consequences of the increasingly connected lifestyles. I join with researchers like Selwyn (2011), who advocate for a critical stance toward the use of technologies in schools. I believe that self-study methodology, particularly when it involves a critical friend to both challenge and support the work, offers a promising way forward.

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Zitieren dieses Beitrages:

Bullock, S. M. (2013): Making the Tacit Explicit: Self-study and the Spectre of Technology Education. Journal of Technical Education (JOTED), 1(1), S. 152-165.