What Does Professional Digital Competence Mean in Teacher Education?

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ABSTRACT
The focus of this position paper is on the conceptualization of professional digital competence (PDC) in the teaching profession and its consequences for teacher education. The aim is to establish a concept that captures, challenges, and possibilities related to teaching and learning in technology-rich settings. By using three school subjects as cases, we argue the necessity of viewing PDC as comprising a deep understanding of technology, knowledge of students’ learning processes, and an understanding of the specific disciplinary practices and features characterizing individual school subjects.

Keywords
professional digital competence, teacher education, integration of technologies, didactics

INTRODUCTION: CHANGING LEARNING ENVIRONMENTS, CHANGING COMPETENCES
In an increasingly digitized and networked world, hardly anyone would dispute the necessity for teachers to possess and execute digital competence. However, exactly what such competence might look like and how it might be put to work...
are questions that defy clear-cut answers. Let us take Norway, with its well-developed digital infrastructure in education, as a point of departure. A number of research projects involving the interplay among learners, teachers, technologies, individuals, groups, and institutions show that the conditions and ecologies for learning and teaching are slowly transforming. However, we also see how digital technologies encounter an educational tradition that is both rich and resistant to change and a mismatch between immature technologies and well-established pedagogical practices (Hauge & Lund, 2012). This has brought about a concern in teacher education with regard to helping students develop a profession-based digital competence relevant to teaching. Inspired by the term “profesjonsfaglig digital kompetanse,” coined by Norwegian Institute for Studies in Innovation, Research and Education (NIFU) (Tømte, Kårstein, & Olsen, 2013), we will refer to this competence as: professional digital competence (PDC) in the teaching profession. A concern for a stronger focus on PDC has been fueled by recent reports showing that there is a mismatch between the digital challenges that newly qualified teachers meet in their profession and the preparations they have received during their teacher education (Gudmundsdottir, Loftsgarden, & Ottestad, 2014).

Nevertheless, how can the problematic lack of PDC in teacher education be addressed? Some indicators can be found by looking at international, research-based, and future-oriented scenarios. For instance, the report Innovating Technology listed 10 innovative trends that will challenge teaching, learning, and assessment in the coming years (Sharples et al., 2013). From these trends a picture of teachers’ digital competence emerges that includes the capacity to collect and analyze data based on learners’ online learning activities (Learning Analytics); connects learning experiences across contexts of time, place, and technologies (Seamless Learning); and facilitates learning settings in which learners learn from the experience and expertise of others (Crowd Learning).

Similarly, the report Technology Outlook on Norwegian Schools 2013–2018 presented “12 technologies to watch” and identified important implications for teaching and learning (Johnson, Adams Becker, Cummins, & Estrada, 2013). This report complements the Innovative Technology report and shows how “more online, hybrid, and collaborative learning models” challenge co-located and individually oriented teaching. Trends to support such claims are found in phenomena such as learners bringing their own devices into education (BYOD), use of social media, technologies suspending limitations in space and time, and access to an abundance of information. Finally, the comprehensive State of the Field Study on ICT in Education (Wasson & Ludvigsen, 2003), with its corpus of 680 scholarly articles, points to the dichotomy between learners’ everyday digital lives and traditional schooling systems that are resistant to change. The predicted growth areas identified in this study include digital gaming, personal learning environments, mobile learning, large-scale collaboration, educational data mining, and strategies for technology-enhanced classroom teaching.
Together these three reports point to an emerging paradigm of teaching that is characterized by complex learning environments and agency for modeling, producing, and enacting innovative educational activities and, consequently, for developing assessment criteria and practices that match this paradigm. However, it remains a fact that teacher education does not sufficiently prepare our student teachers for such learning environments and the opportunities and pitfalls that follow. A recent report on ICT in teacher education from the Norwegian Institute for Studies in Innovation, Research and Education (NIFU) shows that there is low correlation between the integration of ICT in schools and the integration of ICT in Norwegian teacher-education programs (Tømte, Kårstein, & Olsen, 2013). The report questions whether Norwegian teachers are progressing toward PDC. The answers given are overwhelmingly negative. The report finds that the objectives of developing such competences among student teachers are not firmly anchored in teacher-education programs, that there is no coherent approach or well-developed professional profile, and that competence among teacher-education staff varies considerably. The result is that in settings where such competence has been developed, it is vulnerable and dependent on individuals. There are thus few examples to show that teacher-education programs formulate how PDC can be related to what good teacher education actually is. Even though the NIFU’s report is based on data from teacher education for grades 1–7 and 5–10, there is nothing to suggest that the situation is different in the integrated, five-year teacher-education program for grades 8–13 in the Norwegian educational system, which is the focus of this article.

Against this backdrop, we discuss how PDC can be integrated in teacher education on a general level as well as on a more discipline-specific level. However, this first requires a conceptual clarification of what PDC is and what it entails. In the following section, we approach these issues.

THE SCOPE OF THE ARTICLE

The current article is a position paper that aims to contribute to the conceptualization of PDC in the teaching profession and its consequences for teacher education. Our point of departure is not a conceptual exegesis of the term PDC, but rather links it to the disciplinary and situated practices for which student teachers need to be prepared. The analysis and discussion is theory-based, exploratory, and indicative, rather than definitive. We have sought to apply insights from empirical studies as well as sociocultural and activity theoretical perspectives (Engeström, 1987; Vygotsky, 1978, 1986; Wertsch, 1998) in order to give direction to our line of argument. In the study, we build our argument on three fundamental assertions. The first is that we need to move away from understanding digital competence as a set of generic skills suitable for all situations, both personal and professional, and toward an understanding of PDC that includes both generic and specific teaching-profession skills. In the case of teacher education, PDC involves teachers not only appropriating technolo-
gies, but also making their learners appropriate them and put them to productive use. This is an extremely demanding, dual endeavor. The second assertion is that technologies are understood, applied, and made relevant differently in each school subject in which they are integrated. Every school subject encompasses and emphasizes specific conceptual content and accompanying epistemic methods (i.e., the didactics of each subject matter). As applied in the study, didactics can be understood as the design of social practices in which pupils, teachers, and available social and material resources are configured and reconfigured in activities that shed light on subjects, subject areas, and knowledge development and continuously create space for reflection on such activities (Lund & Hauge, 2011a). Therefore, the educational technologies, subject matter, and epistemic skills must be seen as intertwined entities. The third underlying assumption is that we need to educate student teachers that can translate PDC into practices with an ecological validity in order to meet the challenges and needed competences addressed by the reports referred to above. By uniting a view of technology, dimensions of learning theory, and educational science into a subject-specific context, we can see how PDC is expressed both in and as different social practices.

In the current article, we will elaborate on the three assumptions that constitute the underlying basis for our perspective on PDC. The article is divided into three sections. In the next section, we position our perspective on PDC according to a sociocultural perspective of how to understand learning and teaching with technologies (Säljö, 2010; Vygotsky, 1978; Wertsch, 1998). In the second section, we account for the intertwined relationship between PDC and specific conceptual and epistemic features of school subjects. In order to display this intertwined relationship, some dimensions identified in three school subjects—science education, language arts, and social studies—will be used as an analytical point of departure. We emphasize that these are some dimensions among many, but that the aim is to be indicative rather than comprehensive. The third section concludes the article by discussing the implications of our conceptualization of PDC for the practice-oriented dimensions of teacher education. By using the notion of “design” for learning and teaching, we emphasize that PDC constitutes a competence in modeling subject-specific learning environments, learning activities, and learning trajectories conducive to the students’ development. However, this entails a dialectic relationship between teachers’ PDC and learners’ enactment of the intended design, thus making the teaching and learning design a co-constructed effort. This is a fundamental dimension of PDC as we pursue it in a later section in the study.

SOCIOCULTURAL PERSPECTIVE ON DIGITAL LEARNING RESOURCES

From a sociocultural perspective, digital technologies afford users to move beyond existing practices and pave the way for new ones—not least in the field of learning and teaching (Hauge, Lund, & Vestøl, 2007). In this respect digital
technology becomes what is often referred to as cultural tools or artifacts (Säljö, 2010). Such artifacts function as both the gatekeepers to and the glue of cultures, and they possess the potential to transform culture. This view is related to a classic sociocultural perspective, where artifacts mediate cognitive activity and development and are woven deeply into social practices (Vygotsky, 1978, 1986; Wertsch, 1998). Seen as cultural artifacts, digital learning resources store the residue of knowledge and epistemic practices developed over generations. First, this means that centuries of research, discoveries, and scientific discussions are embedded within artifacts by means of different types of textual and visual representations. Consequently, digital learning resources provide potential opportunities for students and teachers to interact with domain-specific knowledge and scientific discourses. Second, digital resources designed for teaching and learning purposes most often embed the residue of what can be seen as ideal epistemic practices. Such practices refer to ways of developing knowledge or expert performances carried out by professionals, experts, or researchers within each knowledge domain and, consequently, its corresponding school subject. These ideal practices and how they intend to support learning activities are often embedded explicitly or implicitly in the design of the learning resources. For instance, in science education, examples of ideal practices can consist of doing lab experiments or engaging in inquiry methods involving activities such as hypothesis generation, evaluating evidence, and constructing explanations (Furberg, 2009). Seen from a sociocultural perspective, this domain-specific knowledge and these epistemic practices are what students and teachers interact with when they employ digital learning resources for learning purposes (Säljö, 2010).

Seeing students’ and teachers’ interaction with and use of technology from this perspective reinforces the need to move away from understanding digital competence as a purely generic set of skills and toward understanding PDC as something that also includes specific teaching-profession skills. Further, this perspective supports the assumption that technologies are understood, applied, and made relevant differently in each school subject. In light of the above-mentioned perspective on technologies, the study examines PDC more closely in relation to the professional disciplines, pedagogy (with a view to educational theory and the learning sciences), and subject didactics, before we turn to the notion of design, to link PDC to practice. Historically, subject didactics has had the weakest link to PDC, but at the same time it is in subject didactics that a scientific discipline is transformed into an educational practice. In the next section, this link will be discussed further.

PROFESSIONAL DIGITAL COMPETENCE IN THE TEACHING PROFESSION

How is PDC in teacher education different from similar competences in other professional fields of study, such as psychology, pharmacy, law, or engineering? One obvious difference is that, in teacher education, the aim is not solely
to educate student teachers as to how to understand and use various emerging technologies that are relevant to the execution of a particular craft or profession. In addition, it involves being able to make their learners capable of using technology and learning resources in productive ways. This represents a major challenge, as it goes beyond the immediate needs of student teachers and involves situations where their knowledge is transformed into discipline-specific didactics, classroom management, and assessment of how pupils make productive use of available cultural resources. As Sandberg and Pinnington (2009) show, professional competence and “distinct use of tools” should be understood as ways of being, i.e., at the very heart of professionalism.

Against this perspective we need to establish a link between PDC and the more comprehensive perspective on professionalism as articulated in the Norwegian National Regulations for teacher education for grades 8-13. These state that teacher education should:

... ensure the coherence between practical and aesthetic subject areas, pedagogy, subject didactics and practice. It shall also include scientific theory and method. [...] and shall give the students a common identity as schoolteachers. (Kunnskapsdepartementet/Ministry of Education, 2013, p. 3. Our translation.)

This points to an integrated teacher education, where the scientific discipline, the professional disciplines (pedagogy and subject didactics), and practice add up to a coherent study program. In light of the citation from the National Regulations, PDC can be understood as something broader than a set of generic (or instrumental) ICT skills, and that is intimately linked to the coherence of the study program. This is completely in line with trends in research in recent years, which show that digital technologies must be considered and appropriated as cultural extensions, closely linked to how we both organize our social lives and develop as humans (Castells, 1996; Gee, 2000; Ludvigsen & Mørch, 2010; Østerud & Skogseth, 2008).

However, in order to establish a link between professional competence and digital competence, we also need a principled view of technology, and must not just resort to metaphors such as ‘tools’ or ‘devices’. In the following section, we limit our approach by discussing what we see as three vital dimensions that can make the conceptualization of PDC visible in the teaching professions: the relationship between digital technologies and learning; how such technologies also bring about performative competence in education; and how structural aspects of classroom management needs to be addressed in teacher education.

The first dimension concerns the relationship between digital technologies and learning. Since the early 1980s, digital technologies have increasingly been linked to theoretical analyses and discussions of learning. Researchers have observed how the conceptualization of what knowledge is (ontology) changes, as well as the assumptions of how knowledge can be acquired (epistemology)
Along with the development of digital technologies intended to support learning and teaching, various learning paradigms (i.e., behavioristic, cognitive, and sociocultural paradigms) have been influential when it concerns how to design and use digital resources (Koschmann, 1996; Shaffer & Clinton, 2006). In addition, several scholars have found strong correlations between teachers’ and student teachers’ fundamental assumptions about learning and ways of approaching technologies (Aagaard & Lund, 2013; Jimoyannis & Komis, 2007; Sime & Priestly, 2005). As Jimoyannis and Komis (2007, p. 152) summarize: “A series of independent studies indicate that both teachers’ personal theories and perceptions about teaching and learning processes and their level of competence with ICT play a major role in how they implement ICT and how they motivate themselves to use ICT tools in the classroom.” Also, the technological development can make perspectives about learning visible that may otherwise remain abstract.

For example, we can consider the use of technologies in relation to behaviorist drills and exercises, cognitive problem solving, collaborative learning, work on simulations and models, or knowledge construction. Learning theories can thus be made visible and become the subject of discussion. PDC can then be directly linked to the teacher’s design of various types of assignments and activities, as well as the learning resources that should be made available to the pupils based on practical circumstances and theoretical validations. The conditions for pupil learning outcomes thus become clearer.

The second dimension of PDC in the teaching profession concerns what Säljö refers to as the “performative” nature of learning (Säljö, 2010). Säljö’s point is that today learning is woven into the use of artifacts, to the extent where we cannot only assess results or documentation of learning but must also include how we arrive at knowledge through relevant, informed selection and use of available cultural tools or artifacts. If we do not do this, both learning activities and the assessment of them lose their ecological validity; they do not correspond with how we in practice and in everyday situations organize ourselves to learn, solve problems, and develop new insights. A challenge thus appears—not only for teacher education, but also for the whole educational sector. The implications of assessing “performative competence” are substantial and they require discussion throughout the sector. However, a feature of competent teachers and PDC for the knowledge society is precisely that of not merely being socialized into existing practices but being able to contribute to the development of new ones (Edwards, Gilroy, & Hartley, 2002; Kollar, 2010; Lund & Hauge, 2011).

A third vital dimension of PDC in the teacher profession concerns issues that arise when pedagogy meets technology in the classroom. One is classroom management and a view of technologies as disruptive and detrimental to focusing on learning objectives (Krumsvik, Egelandsdal, Sarastuen, Jones, & Eikeland, 2013). Blikstad-Balas (2014) for instance shows that when pupils in the final year of upper secondary school (in Norway) are given access to digital technologies and the Internet, they spend a disproportionate amount of time on
non-scientific activities such as games, Facebook, online newspapers, and aimless surfing. This is a question of classroom management, but there is strikingly sparse literature on classroom management in complex, technology-rich learning environments. One exception are the guidelines from the Norwegian Centre for ICT in Education (IKT-senteret, 2013), but the many suggestions and advice are not sufficiently linked to PDC or to a research-based knowledge platform. Roughly speaking, two strategies can be used to address the problem of deficient pupil attention: a technical or a social regime. The technical regime can be practiced through software that can limits or blocks pupil uses of technology. In a world characterized by the pupils’ own mobile technologies, this alone is not sufficient. A social regime must therefore also be established that is exercised through common rules or conventions and that clearly distinguishes between irrelevant activities and assignments and activities that require or are supported by digital technologies (Krumsvik et al., 2013).

Our examination of PDC in pedagogy and the teaching profession has focused on three vital dimensions. First, we have linked connections between views of technology and learning with the implications this has for a scientific basis for PDC. Second, we have drawn attention to the problem of how the performative nature of learning makes it difficult for teachers to use traditional forms of assessment and assessment criteria. Third, we have emphasized how PDC must allow space for the development of structural aspects of classroom management in technology-rich learning environments, and how access to both information and entertainment can erase the boundaries between these and threaten the learning object. This is in no way an exhaustive analysis of what PDC entails in pedagogy, but we argue that it shows how we can make this dimension of PDC more specific in integrated teacher education.

SUBJECT DIDACTICS

Although the aspects of ICT and PDC that have been highlighted previously may appear generic to the teaching profession, they are also expressed in various ways in the various subjects. In the current Norwegian national curriculum, digital literacy is considered a fundamental competence on par with reading, writing, speaking, and numeracy, and in the various subject-specific syllabi we find certain competence goals connected with digital literacy. However, these are mostly broad and do not capture what exactly digital literacy entails in the particular subject. This is why in the following we take a closer look at how subject didactics for the networked society involves insights into how digitalization affects knowledge concepts and knowledge practices in the relevant school subject. Research has for many years produced classroom studies in which the axis of the analyses has often been between technology and activities or learning outcome, irrespective of the characteristics, traditions, and purposes of the subjects. In recent years, a growing number of studies have been produced that also include the subject’s special features and how
digital technologies are linked to these (Kelly, Luke, & Green, 2008). When we address three knowledge domains, below, it is not to give an exhaustive account of the opportunities and constraints technologies represent, but to give some indications of subject-specific features that together suggest that ICT in school subjects cannot be approached from a merely generic position.

Also, contemporary students increasingly assume the role of knowledge producers rather than simply consumers (also referred to as ‘prosumers’) of textbooks and the material conveyed by teachers. In science education, we can see a larger repertoire of knowledge representations through models, simulations, and virtual experiments (Furberg, Kluge, & Ludvigsen, 2013; Linn & Eylon, 2011). In language, we encounter an extended concept of text in the form of multimodality and web-based environments that make it possible to communicate regardless of time and space, and in a number of different contexts (Bakken, 2007; Lund & Rasmussen, 2008). Social studies encounter challenges in the form of unlimited access to information, which can at the same time be fragmented and even contradictory (Furberg & Rasmussen, 2012). By using three subjects—science education, languages, and social science—as an analytical point of departure, we will illustrate how the dimensions of subject didactics can be linked to PDC.

Science Education

Among the implications that technological development has for learning and teaching practices in science education, we call attention to two central learning aspects. The first concerns how technology has made it possible to present scientific concepts and phenomena in new and diverse ways. Complex and abstract scientific concepts that were only accessible to highly science-literate people have become more accessible for laypeople, including students (Linn & Eylon, 2011). A common feature of digital knowledge representations is that they display abstract and complex scientific concepts by means of visual representations, such as interactive animations, models, and simulations, as well as offering supplementary text-based sources that enable new combinations of depictive and symbolic representations (diSessa, 2004; Furberg, Kluge, & Ludvigsen, 2013). In this sense, digital resources have qualities that can contribute to making abstract scientific concepts more tangible to students (Furberg et al., 2013; Linn & Eylon, 2011).

The second learning-related aspect concerns how technology provides opportunities for students to develop an understanding of, as well as skills in engaging in, scientific methods. Many studies have shown how various forms of technology can support students in inquiry learning settings. Inquiry is defined as the scientific process of generating hypotheses, collecting data through systematic investigations or experimentation, interpreting data, and drawing conclusions (De Jong, 2006; Linn & Eylon, 2011). Numerous computer-based learning environments have been developed with the aim of engaging and sup-
porting conceptual and epistemic understanding (Bell, Urhahne, Schanze, & Ploetzner, 2010; Linn & Eylon, 2011; Quintana et al., 2004).

Several studies have reported positive effects of students’ engagement with various types of digital learning resources, such as simulations (Rutten, van Joolingen, & van der Veen, 2012; Smetana & Bell, 2012), multiple representations (Ainsworth, 2006), and virtual labs (Baltzis & Koukias, 2009; Kozma, 2003; Zacharia, 2007). Studies also show the effects of students’ use of digital learning tools or environments aimed at supporting their inquiry skills and understanding (van Joolingen, de Jong, & Dimitrakopoulou, 2007). There are also studies reporting findings that are more challenging, for instance that students tend to focus more on the surface features of digital representations than the underlying scientific principles (Ainsworth, 2006). In addition, even when supported by digital tools, students struggle with, for instance, in testing hypotheses, connecting procedural skills with conceptual knowledge and transferring inquiry skills from one setting to another (van Joolingen et al., 2007). As well as highlighting the potential of student engagement with digital resources in science education, the more challenging findings underline the need for science teachers with a PDC that provides conceptual as well as structural support in computer-supported learning settings (Furberg, in progress; Strømme & Furberg, in review).

Even though there is a fair consensus of the significance of teacher involvement in technology-rich learning settings, several researchers point to a lack of studies that analyze its specific role. However, the studies that focus on teacher intervention in computer-based learning settings find that teacher intervention in the form of conceptual elaborations (Furberg, in progress), eliciting of intuitive ideas (Strømme & Furberg, in review), and teacher-led consolidation activities, such as plenary introductions of new tasks, evaluations, and classroom discussions (Mäkitalo-Siegl, Kohnle, & Fischer, 2011) have positive impacts on learning processes.

Taking the conceptual and learning-specific issues characterizing science education into account, displays how PDC is highly interwoven with the concepts and epistemic methods belonging to the school subject. In science education this can be exemplified by a competence in designing learning activities, which involve the introduction of complex scientific concepts by means of digital knowledge representations, and productive use of digital tools designed for supporting inquiry learning processes. Most importantly, however, PDC in science didactics involves understanding the specific concepts and scientific processes that students struggle with, as well as how digital tools can provide productive support for students, an understanding that emerges as a highly subject-specific competence.
Languages

In languages digital and networked technologies have transformed both the subject matter and the literacy practices in which students take part (Blikstad-Balas, 2014). First, technologies affect language itself, its lexico-grammatical structures and emerging genres, outputs, or conventions (SMS, e-mail, blogs, many-to-many forums, digital storytelling, etc.) (Lie, 2011; Schwebs & Otnes, 2006). David Crystal considers “Netspeak” a third mode of expression besides spoken and written language (Crystal, 2001). Moreover, he introduces “Internet linguistics” as a new research field (Crystal, 2011). Add to this that the many modes and varieties of a language are accessible (text or audio) through a couple of keystrokes, and we have a situation in which the phrase “authentic language” needs to be redefined. We also increasingly communicate in faceless modes or via digital video. In sum, we see new communicative spaces and a new communication ecology (Friedland & Kim, 2014). Another challenge is how to deal with language that does not adhere to traditional standards (Lie, 2011). The difference between a mistake and unorthodox spelling, between registers and conventions, puts linguistic competence among teachers to a serious test.

Second, the ways we create and interpret texts are greatly affected by digital technologies. Although, by now, word processing seems mundane and trivial, it has been instrumental in changing how we understand and practice writing. In his early but exhaustive analysis, Heim (1987) demonstrated how word processing took writing out of the sequential paradigm and turned it into a cyclical and perpetual process of rewriting and revising, or “sculpting” a text. This is, of course, of utmost importance for a language teacher in to know. Additionally, creating texts in modern language arts subjects is not restricted to speaking or writing alone. Today’s learners and teachers can choose from and combine different modalities, such as drawings, photographs, animations, and music, to create a great variety of multimodal texts. Thus, language teachers need a theoretical understanding of multimodality and insight into different kinds of multimodal digital genres and media in order to guide and assess their learners’ language production (Løvland, 2007).

Faced with the expanding volume and complexity of multimodal hypertext on the Internet, students also need to develop a new set of reading strategies (Roe, 2011; Stromsø & Bråten, 2006). As pointed out in the reports from the PISA Digital Reading Assessment in 2009, digital reading demands highly developed strategies for navigation, selecting relevant information and comparing information from different sources (Frønes, Narvhus, & Jetne, 2011). Although these are competences relevant to all school subjects, the systematic development of reading strategies traditionally falls within the domain of the language arts. In conclusion, PDC in language arts didactics involves an understanding of how digital technologies are shaping language and texts in today’s society and an ability to design learning activities that help students find their place in this digitalized textual culture.
For the aspiring teacher, there are important implications for exerting PDC, including communicative expertise. Student teachers need to be exposed to and assess a vast variety of linguistic and communicative conventions that have emerged. What is more important, they need to assess such conventions in their learners’ work; what amounts to successful multimodal expressions, when are they within relevant register and discourse, and where do we cross the threshold for acceptable language use? As recent research shows, such questions represent an extension of the classical Vygotskian theory (1986) of how doing language, “languaging,” is a key process that allows the shaping and organizing of higher mental processes through language (Swain, 2011).

Social Studies

Within the field of social studies, educators differentiate between two main types of learning: the acquisition of content knowledge and the development of historical thinking and understanding. The former is often connected to direct instruction and the attainment of substantive knowledge, while the latter is connected to inquiry-based learning and the development of skills that make the pupil able to act and think like a historian (Stearns, Seixas, & Wineburg, 2000; VanSledright, 2004). With the advent of the World Wide Web, teachers and teacher educators have elaborated on the opportunities that technologies bring to enhance learning in social studies (Debele & Plevyak, 2012). Access to the Internet meant access to information in general, and primary sources in particular. The use of historical evidence has been a part of established teaching practices for a long time (Barnes, 1896), but the growth of online multimedia databases (Bull, Hammond, & Ferster, 2008), “Digital history” or sourcing, made new and other types of evidence easily available. Through the development of structured, themed “packages,” digitalized photographs, films, and primary documents made their way into social studies classrooms (Biland, 2010; Clarke & Lee, 2004). Researchers have undertaken to assess whether the use of these new technologies, in combination with different instructional scaffolding strategies, were effective in developing content knowledge and/or their historical thinking among pupils (Davis, Fernekes, & Hladky, 1999; Lee & Molebash, 2004). At the same time, technologies developed to present information rapidly became mainstream technology. The use of search engines such as Google and online encyclopedias such as Wikipedia to find information or evidence has become a common strategy for most pupils, one that perhaps challenges the notion of the teacher as a “gatekeeper” of content knowledge (Blikstad-Balas, 2014). These technologies, designed to search the web and gather information and then present it to others, are still very much in use today, and also in structured approaches such as WebQuest’s (Kurt, 2012; Li & Lim, 2008).

With the development of Web 2.0 technologies, teachers and teacher educators discovered the potential in letting pupils create their own historical representations through wikis, blogs, podcasts, or video documentaries (Manfra & Lee, 2011; Yang, Chen, & Chen, 2002); travel through virtual time and place (Comp-
ton, Davis, & Mackey, 2009); or participate in simulations and game-based learning (Squire & Barab, 2004). Through the use of inquiry-based strategies (Hernández-Ramos & De La Paz, 2009) and technologies that enhance collaboration and collective knowledge building, pupils are encouraged to challenge the notion of transfer of knowledge that is often represented in textbooks.

For student teachers, the advent of digital and networked technologies opens up new horizons for “doing” history and thinking like a historian. At the same time, technologies in social studies open up a vast array of complex issues connected to surveillance, manipulation of information, citizenship, democracy, and freedom of speech. The teacher’s role is thus partly transformed, partly challenged by the abundance of available but often questionable or downright faulty information. This is a major task for teacher-education programs that need to prepare students for coaching learners in a networked world.

PDC IN PRACTICE: AN INTEGRATED CONCEPTUALIZATION

The rapid digitalization of information has resulted in changes to the concept of knowledge, its representations and knowledge practices, as learning increasingly involves the use of cultural resources (Säljö, 2010). Hence our notion of design as the design of social practices involves configuring and re-configuring resources (cf. our definition in the section on the scope of the article). In addition, an abundance of information can readily be located in vast digital archives (Säljö, 2010). There is, therefore, no doubt that through their education, teachers must become familiar with research-based knowledge about this development and must themselves be given the opportunity to develop teaching practices in and for technology-rich learning environments. In order to design productive learning activities that involve ICT, we have argued that, in teacher education, it is not enough to recognize certain pedagogical attributes of the technologies; it is important to acknowledge that different activities within different subject domains bring forth certain qualities in them that can be conducive to learning.

The implications are that teacher education on the one hand needs to focus on the aspects of digital technologies that are generic to the teaching profession, as we have discussed in the section on PDC and pedagogy: how they are linked to fundamental assumptions about learning and teaching, how they have epistemological consequences, and how they might disrupt existing practices. Of equal importance though, is that teacher education also must be sensitive to the more specific disciplinary practices and features characterizing each individual school subject. When these two dimensions are combined and used to design and enact learning activities, we arrive at a truly integrated approach to PDC, where the scientific disciplines, the professional disciplines (pedagogy and subject didactics), and practices add up to a coherent whole. The integration of these dimensions is central to the design of learning environments and learning trajectories (Hauge et al., 2007; Lund & Hauge, 2011). It is in the
design that generic and subject-specific aspects of the technologies merge and are operationalized in educational practice.

From a pedagogical perspective, the design concept was introduced by Donald Schön (1987) who, inspired by John Dewey, linked it to professional practice and reflection on practice. Schön applies the concept of design to professions that transform existing situations and practices into desired and future-oriented practices. From the design perspective, there is thus the wish to find the best possible alternatives when faced with a problem or a challenge—what Schön calls “reflection-in-action.” In the past two decades, we have seen how the design concept has been linked not only to the development of both software and user interfaces but also to learning and teaching environments (Laurillard, 2012; Lund & Hauge, 2011; Selander, 2007). Facilitation of design activities in teacher education can be conducted as a combination of lectures, seminars, and workshops. The lectures and seminars might focus on the pedagogic and didactic dimensions of PDC, whereas the workshops could be actual design activities within specific or cross-disciplinary domains. In such design activities, a typical approach might consist of:

- Defining a learning object and discussing how learners and teachers should approach such an object.

- Selecting and employing cultural resources (material as well as human) conducive to working toward the learning object and producing results.

- Addressing the conditions under which the activities unfold: institutional rules and regulations; the total learning community (individual, class, and beyond); division of labor between those involved and the duration of the activity (Engeström, 1987; Kaptelinin & Nardi, 2006; Lund & Rasmussen, 2008).

- Testing the intended design as developed by student teachers in actual practice to see how it is picked up and enacted by learners in schools.

- Sharing experiences that show how intended designs related to enacted designs (online, e.g. in a wiki or LMS, or as debriefing sessions on campus in order to foster collaborative approaches to the teaching profession).

Obviously, this is a very simplified framework for quite demanding professional work involving all the aspects of PDC discussed. Also, such efforts to develop and cultivate PDC are fruitless unless they are matched by exams and assignments that display similar features. Therefore, important and challenging work remains to be done with assessment criteria that include PDC (e.g., how student teachers display performative competence, design competence, and integrative competence). Let us end with an example where this is sought and operationalized. At the Department of Teacher Education and School Research, University of Oslo, exams have been digitized in recent years. This does not mean merely
that pen and paper have been replaced by keyboard and screen. During exams, student teachers are allowed to collaborate and choose whether they want to work from home or from campus. All resources are available, including use of the Internet. The exam task takes as a point of departure a digital video clip showing a situation from a classroom. Student teachers are then asked to draw on their knowledge of pedagogy and the learning sciences, subject didactics and experiences from practice, in order to develop a problem statement and discuss it. Thus, there is an integrated approach to the exam, which increases its ecological validity; the exam setting mirrors typical opportunities and challenges that add up to the everyday enactment of the teaching profession. In sum, this particular type of exam is a result of a design approach where the intended design was constructed by the university teachers but enacted as a learning design by the student teachers as they responded to the task in various ways.

CONCLUSION

The overall aim of the current article has been to contribute to the conceptualization of professional digital competence in the teaching profession, and its consequences for teacher education. Initially, we identified some trends that add up to what our student teachers will encounter in their current and future practices, and how this calls for a principled view of technologies as artifacts that have transformational potential. Next, we linked PDC to the professional disciplines (i.e. pedagogy and subject didactics). By doing this, we have seen how PDC emerges as something much more than a skills-based competence, a complex competence that requires theoretical as well as practical approaches in the form of designs. We have also discussed the implications for teacher education. Instead of exemplifying what might add up to certain modules or workshops, we have advocated the notion of design as a way to integrate and enact the many dimensions of PDC. In both cases, it has not been our intention to suggest that this is the definition or demarcation of PDC. However, we have wanted to raise a discussion of what PDC involves, what is at stake, and how teacher education can be sensitized as to what fostering PDC requires. Hopefully, this and similar attempts can operationalize a sorely missed dimension in teacher education become and prepare our student teachers to develop future-oriented designs for teaching and learning.

REFERENCES


