Teacher education as design: technology-rich learning environments and trajectories

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Abstract

Traditional school subjects are being challenged by the accelerating production and development of knowledge in all domains. This creates a need to educate student teachers not only to appropriate existing practices but to be prepared to take the initiative in designing and developing new ones. This paper examines the challenges that confront teacher education when both the amount of information and its complexity are increasing due to the growing use of technology. We argue first that we need a richer view of technology than is often found in decision documents and in some of the didactics literature. We then introduce the concept of design as both an analytical and a didactic concept that links technology-rich environments and learning trajectories to knowledge development. From an activity-theoretical perspective, we approach the notion of design as a key component in teacher education and consider how it materializes through the use of a wiki, and in a new type of exam. The aim is to contribute to enhancing the quality of teacher education by making visible some of the more underlying qualities of what professional ICT competence can entail.

Keywords: teacher education, educational designs, view of technology, collaborative learning

Introduction

Teachers' professional development in the knowledge society is inextricably linked to what is perceived as valid knowledge at any given time (Kelly, Luke, & Green, 2008). School subjects have traditionally been associated with stable and often standardized expressions of knowledge, communicated by teachers and verified through various forms of tests and examinations. However, as has been shown, for instance, by Edwards, Gilroy and Hartley (2002), traditional school subjects are being challenged by the accelerating production and development of knowledge in all domains. This creates a need to educate teachers who are not only socialized into existing practices but who are also themselves prepared to take the initiative in developing new ones. According to Edwards et al. (2002), a key to revitalizing teacher education is to develop students' relational expertise—in other words, the skills required to work across knowledge domains. Hargreaves (2003) is also preoccupied with this,

pointing out that existing models of teacher education hinder innovation and, in fact, contribute to the disintegration of innovative communities.

This paper examines the challenges that confront teacher education when both the amount of information and its complexity are increasing due to the growing use of technology. We argue first that we need a richer view of technology than is often found in decision documents and in some of the didactics literature. We then introduce the concept of *design* as both an analytical and a didactic concept that links technology-rich environments and learning trajectories to knowledge development. In addition, we attempt to relate both this view of technology and this concept of design to development projects taking place at ProTed (the Centre for Professional Learning in Teacher Education), a Centre of Excellence at the Department of Teacher Education and School Research at the University of Oslo. To summarize, we argue that this approach constitutes a basis for a principled approach to professional digital competence for teachers.

The need for a rich view of technology

The use of ICT in higher education in Norway has often lacked a clear vision of technology. As Haugsbakk (2011) shows, following a review of relevant planning and decision documents, the premises for investment in technology have lacked clarity while at the same time technology itself has gone through considerable changes. According to Haugsbakk, teachers' pedagogical judgments have also often been replaced by more instrumental perspectives on the development of technology and of society, and he claims that little or no attention has been paid to how the use of technology can result in greater complexity, doubt, and uncertainty (ibid., p. 249). As a consequence of an instrumental approach, digital technologies have often been described metaphorically as 'instruments' or 'tools'. Tools are something we develop to ease or automate processes, to save time (and money) and to achieve results more efficiently. Teacher education has traditionally offered students courses on various types of digital tools for use in schools. As Haugsbakk points out, the challenge of metaphors such as 'tools' is that they reduce or hide complexity. They also obscure the potential that digital technologies possess to go beyond and transform existing practices and to pave the way for new ones—not least in the field of learning and teaching (Hauge, Lund, & Vestøl, 2007; Lund & Hauge, 2011b). For the same reason, this also becomes a particular concern for teacher education.

There is a need to theorize the relationship between tool and agent in order to unpack this relationship's inherent potential and what is at stake when it is integrated into learning and teaching activities. The relationship between agents and tools has attracted significant attention from various theoretical perspectives, especially from Actor Network Theory (ANT), Distributed Cognition (DC), Phenomenology, and Cultural Historical Activity Theory (CHAT) (see for instance Shaffer & Clinton, 2006 for an extended discussion). In drawing here on CHAT, it is because, more than ANT or DT, CHAT clearly distinguishes human agency from agency and inscriptions embedded in tools, and more than Phenomenology, it connects cognition to institutional affordances. Our position is that human agency and institutional affordances are fundamental concerns when developing teacher education.

As, for example, Roger Säljö has shown (Säljö, 1999, 2000), some tools assume the role of cultural implements or *artifacts*. As its prefix indicates, an artifact is an artificial product, constructed for specific purposes. These products are developed over time and are therefore the carriers of historically and collectively developed insights within one or more areas of knowledge. Artifacts can function as both the gatekeepers and the glue of cultures, but

they also possess the potential to change our culture, to open it up to new practices. For example, the plough is the result of generations of experience of cultivating land and is a carrier of collectively developed knowledge of both agriculture and physics. The latter became clear when a plough was developed in England in the 18th century with a 'twisting mouldboard' that enabled the plough not only to slice the earth but to turn it over. In many ways the plough is both the gateway to and the glue of agricultural society. At the same time, the plough transformed this culture and pointed it towards industrialization. In this sense, an artifact is more than a tool applied to existing practices; it transforms not just the practice but also the agent engaged in the practice.

It is from this kind of perspective that we approach digital technologies. As early as 1987, Michael Heim pointed out that as well as facilitating the work of writing, word processors also changed the actual writing process. From being restricted to horizontal lines and vertically organized pages, we could now fashion the language by moving and replacing chunks and paragraphs. According to the philosopher Heim, this is an expression of how thought itself is formed through a technology that changes the way we express ourselves (Heim, 1987). Hardware, software, applications, and web-based resources are currently regarded as an expression of human insight in almost all knowledge domains. They function increasingly as the gateway to and glue of the network society (Castells, 1996), and they have the potential to transform our culture in fairly dramatic ways, whether in respect of research and education or of interpersonal contact. For example, in Norway we have statistics to show that, on an average day, 76% of children between the ages of 9 and 12, and 91% of adolescents between the ages of 13 and 19, use the Internet (Egeberg et al., 2012). In schools, we can see how digital technologies open up to multimodal genres, dynamic and interactive forms of representation (maps, simulations etc.), and communication where the limitations of time, place—and to some extent, culture—are transcended. But at the same time, there is evidence that newly qualified teachers in Norway find a mismatch between digital practices in school and a lack of digital practices in their teacher education (Gudmundsdottir, Loftsgarden, & Ottestad, 2014). Another recent report shows that while ICT competence is fostered in teacher education, this is still mostly because of engaged individuals, it is arbitrarily scattered among institutions, and there is seldom a principled approach anchored in the leadership of those institutions (Tømte, Kårstein, & Olsen, 2013).

As artifacts, digital and networked technologies have the potential to link the lifeworlds of pupils and schools to the development of students as professionals. In other words, we see the possibility of attaining a higher degree of authenticity and relevance in the tasks and activities engaged in by students. Such technologies unite students who retrieve, share, and produce subject-relevant content, fashioning parts of the world they are being prepared for, and offering multiple forms of representation of the phenomena being studied. This in turn has an impact on task design, learning activities, teaching methods, and assessment. What student teachers do during their education must be aligned with the conditions they will encounter elsewhere in the educational system. But this is a system where the 'finite' or 'controlled' relations between textbooks, tasks, and teachers are increasingly challenged— and, indeed, replaced—by an infinity of relations to information and other agents, and where artifacts (spell checkers, translation programs, pocket calculators) may contribute to building a performative competence that outstrips our non-artifact-supported competence (Säljö, 2010). We encounter a new communication ecology (Friedland & Kim, 2014) in which complexity increases and predictability decreases because of the many and shifting relations between agents, artifacts, institutions, groups, and media types. Such learning environments also afford a role for pupils as producers of content and not just as consumers. We argue that these trends need to be adopted in, and adapted to, teacher education.

Against this backdrop, we introduce the concept of *design* as a key component of teacher education, as a means of preparing student teachers for the uncertainty, high complexity and multiple affordances of the networked society, and to make student teachers capable of developing new practices, in addition to mastering those that already exist.

Designs for learning and teaching

In our discussion of perspectives on technology (above) we briefly explained why we have adopted a CHAT perspective in the present study. In linking CHAT here to the notion of design, this reflects CHAT's emphasis on the object as the collective motive for activities such as, for instance, learning and teaching (Kaptelinin & Miettinen, 2005). Additionally, CHAT makes it possible to see how the various stakeholders engaged in a community participate in order to transform the (learning) object into tangible results. We refer to this process as design, and it involves configuring and re-configuring relations between agents and artifacts regulated by institutional factors, as found in rules and conventions, the larger community of practice involved, and how work is negotiated and divided between stakeholders.

Design is a vague concept, partly because it is used in a variety of disciplines and knowledge domains—for example in architecture, art products, advertising, and technology. Within a pedagogical perspective, the design concept was introduced by Donald Schön (1987) who, inspired by John Dewey, linked it to professional practice and to reflection on practice. Schön applies the concept of design to professions that transform existing situations and practices into desired and future-oriented practices. In the design perspective, there is therefore a wish to find the best possible alternatives when faced with a problem or a challenge—what Schön calls 'reflection-in-action'. For Schön, design is always oriented towards meaning-making and identifying wholeness in situations, and connections between series of actions that are characterized by complexity, instability, value conflicts, and the unexpected. Design is in part informed by experience and theory and in part comes into being as it is applied in the practice situation—much as jazz musicians use a theme and a series of chords to support their improvisations on the same theme and series. But for Schön this also applies to teachers, and his concept of design therefore goes much farther than planning a lesson or an activity.

An activity theory approach to design (Hauge et al., 2007; Lund & Hauge, 2011a) places emphasis on linking learning activities, their direction and intentionality—for both teachers and pupils—to the learning object. In this perspective, the learning object is perceived in two ways, giving direction to activities at the same time as it manifests in different ways during the process (Kaptelinin & Nardi, 2006). Pupils and teachers construct and reconstruct the object as the design gradually assumes an increasingly relevant direction and form in relation to the tasks to be resolved. Hauge, Lund and Vestøl (2007) distinguish between two complementary aspects of design. *Design for teaching* is basically the teacher's responsibility and emerges through the teacher's interpretation of curricula and competence aims, lending an institutional dimension to this aspect of design. *Design for learning* is an expression of what happens in the actual learning situation—what is enacted or played out when pupils and teachers work together to realize the learning object. While design for teaching limits and anchors the activities, design for learning is more context-sensitive and will, for example, respond to pupil initiative and to unexpected opportunities resulting from access to cultural resources (e.g., the Internet) and from negotiations and discussion. Hauge et al. (2007) have shown examples of this in how pupils (and teachers) have tried to create an understanding of how acts of terrorism can arise and on what grounds—in this case, the hostage taking led by Chechen rebels against a school in Beslan in Russia, in 2004. This event was beyond most people's

comprehension; the teacher could not be expected to provide a satisfactory explanation, and the information on the Internet was contradictory. The pupils therefore had to attempt to construct a presentation themselves, which was debated in plenary. In this way, the combination of the two design aspects has the potential to build a bridge between the various lifeworlds of the pupils and common institutional goals. As artifacts that mediate between diverse cultural contexts and partially different activity systems, we regard digital network technologies as a crucial cornerstone of this bridge-building.

But the relationship between designs for teaching and designs for learning is nonetheless under-theorized. Lund and Hauge (2011a) have elaborated and theorized this relationship. The Vygotskyan concept of *obuchenie* occupies a central position in this work.

Obuchenie, didactics, and design

Obuchenie is a Russian term that is vital for understanding Vygotsky's theories of development. The term describes the activities of both teaching (instruction) and learning. This complexity makes the term difficult to translate as one simple word or expression (Cole, 2009). The term is closely connected to Vygotsky's theory of the zone of proximal development, where knowledge development is a two-way process involving collaboration between teachers and pupils. However, what the term does not make explicit is another fundamental assumption within the sociocultural perspective and in our understanding of design: the important role that cultural tools or artifacts play in development. This becomes clear in later explanations, as for example by Cole (p. 292):

> In general, the Russian word, obuchenie, refers to a double-sided process, one side of which does indeed refer to learning (a change in the psychological processes and knowledge of the child), but the other of which refers to the organization of the environment by the adult, who, it is assumed in the article under discussion, is a teacher in a formal school with power over the organization of the children's experience.

This quotation links *obuchenie* to a teaching design, and to available resources, by emphasizing "the organization of the environment". Although the relevance for digital technologies becomes clear here, the learning design is also pointed out—as well as the knowledge development of the individual who is learning. *Obuchenie* thus emerges as a dialectic concept in which teaching and learning are mutually constitutive of (cognitive) development. Thus, when introducing the notion of design into teacher education, we see how the concept bridges intentions and actions for teachers as well as for learners. It also captures the physical dimensions of the classroom and its extended virtual space, together with a non-dichotomous (learning and teaching) approach to education.

In the same way as *obuchenie* has influenced our understanding of design for technology-rich activities, the concept also affects how we seek to develop the notion of didactics. In the European tradition, didactics is firmly based on democratic ideals—reflection on learning and teaching, and how these become part of education's formational dimension (*Bildung*) (Gundem, 1998; Klafki, 2001). However, the Anglo-American tradition often links the concept of *didactics* to more instrumental and normative dimensions such as planning, choice of method, and predefined goals (Hamilton, 1999). Within this latter tradition, interaction and the use of semiotic and material resources are not always as important. This is what Selander (2007) emphasizes when he formulates a notion of didactics that includes interactivity in physical, collective, and virtual space. In understanding didactics as a response to the questions of what to teach, how to teach it and why, online learning environments will also challenge us on questions about *when* and *where* to

teach. Digital technologies have the quality (among many others) of being able to transcend or suspend limitations of time and space, and so we see that when introducing the notion of design into teacher education, spatio-temporal issues also become crucial.

Nonetheless, we argue that a clearer focus is required, both on practices and on the learning object. We propose that activity theory offers us a system of concepts for developing didactics in a way that will capture the complexity of teaching and learning activities that take place both collectively and individually, and for which the availability of cultural resources and artifacts (both material and social) is growing.

In our view, one way of developing teacher education in the next stage would be to add a clear design element. Designs can be used as a way of constructing and orchestrating learning environments and learning activities over shorter or longer timescales. But a design approach can also be used to analyze real-life or videotaped situations from classrooms. In this paper, we have emphasized design as vital for the attainment of professional ICT competence, as called for in the report on ICT in teacher education from the Nordic Institute for Studies in Innovation, Research and Education (Tømte, Kårstein, & Olsen, 2013). However, the ICT element is no *sine qua non*; providing designs for both learning environments and learning trajectories in general must be assigned key importance if student teachers are to be prepared to lead learning in increasingly complex and future-oriented situations. In the following, we present and discuss examples of how this can be implemented. These empirical examples do not qualify as research studies, but are included here as empirical carriers of some of the more conceptual and theoretical aspects discussed so far.

The student teacher as designer

In 2012–2013, the Department of Teacher Education and School Research (ILS) introduced a new integrated study design for their Teacher Education Programs. The overall goal of the new model is to educate a new generation of "Learning Professionals" (Boshuizen, Bromme, & Gruber, 2004) by enabling student teachers to become adaptive experts (Darling-Hammond, 2012). The program of study now has a design with common and *integrated* learning outcome descriptions for the subject areas of educational theory, subject didactics, and teaching practice. All the examination assignments are also integrated; one of these is a semester assignment that students work on in pairs throughout the first semester, including the practice period. The design of the examination assignment aims to create stronger bonds between students' experience from their teaching practice and their learning work on campus in order to develop students' relational expertise (cf. Edwards et al., 2002). During their practice period, students hand in four part-assignments in which they document their practice experience and collect empirical material. This includes observing a class and documenting the implementation of a teaching plan and the supervisor's feedback on this. On the basis of this work in their teaching practice, students write a semester assignment in which they discuss the relationship between the design for teaching design and pupils' learning. By integrating learning work both in teaching practice and on campus, a design of this kind paves the way for greater authenticity and professional relevance in the examination work. At the same time, it prepares students for having to relate to a knowledge world and a work situation steadily increasing in complexity.

When the design for examination was first put into practice, students from three of the didactics subjects in the program (Norwegian, English, and history) participated in a pilot project under the auspices of Development Area 3 at the ProTed Centre for Professional Learning and Teaching Education,

Digital learning environments. The objective of this area is to strengthen students' learning progression by creating digital, flexible learning environments. This pilot project required students to do all the writing—both on the part-assignments and on the final semester assignment—in a wiki rather than submitting text documents in a learning platform, as was the case for the other students. One common wiki was used for all students and lecturers participating in the project, which meant that everyone had the opportunity to read each other's texts at all stages of the writing process, lending a strong collective dimension to the design. However, access to the wiki was closed to those who were not involved in the project.

On the basis of what we have earlier referred to as an instrumental approach to technology, such use of a wiki in examination work could be considered a tool or an implement—something that facilitates an existing practice. Instead of writing on a word processor and then submitting the end product in a learning management system, students write the text directly into the wiki. They then need only one digital tool, and this saves the work of submitting the text. However, the purpose of this pilot project was to study whether the wiki could function transformatively by contributing to transcending existing practices and establishing new ones (Hauge et al., 2007; Lund & Hauge, 2011b). The evaluation conducted among the students after the semester assignment was handed in to some extent confirms that such an effect. The majority of the students said that they read others' texts during the process, and that this gave them inspiration for their own work on the semester assignment. For example, one of the students writes: "I think it was instructive to see how others formulated their assignments. It was also a support for me to see whether I'd misunderstood anything by comparing layout etc." The students' writing thus became part of a collective knowledge development. In addition, some students emphasized the value of taking part in others' practice experience in addition to the actual work on the examination assignment. One student writes: "I got some tips on structure and approaches. [...] It was also interesting to learn about other areas, bearing in mind the exam and working life." Lecturers reported that the wiki gave them good access to students' experience while they were doing their teaching practice so that it was possible to include this experience in the teaching on campus.

These experiences have been incorporated in a new exam design at the Department of Teacher Education and School Research (ILS) at the University of Oslo, where student teachers on the five year integrated master's level program meet this design for the third time. The exam design includes a task requiring student teachers to draw on their expertise in a particular subject, in pedagogy, and in subject didactics—but also on relevant experience from their practice in schools. The task is available online from the very first day the students start the course, but how it will be approached by the student teachers is decided by a digital video case that students encounter on the day of the exam. The task is constructed so that the student teachers can choose to work from home or from campus, individually or in pairs or small groups. These elements constitute the campus teachers' design. However, how the student teachers approach and choose to respond to the task cannot be predicted, nor can a uniform response be expected. At the time of writing this paper, exam papers are analyzed in order to see, for example, how student teachers succeed in making integration visible, whether they take a subject as a point of departure (pedagogy, the video case etc.), and to what extent their analysis of the video case draws on multiple sources of knowledge. This effectively amounts to an analysis of the students' learning design. In sum, the design approach is operationalized in the educational activities that constitute the teacher education program(s), as well as being a way of developing study designs among the staff.

The design approach, using the wiki for work on the semester assignment in the PPU program and at exams in the five-year integrated master's program,

seeks to address two big challenges in today's teacher education. First, it contributes to building a bridge between theory and practice, and between experiences on campus and in the practice field. Through the wiki, those who teach on teacher education programs can follow students' activities during teaching practice, and students can bring their documented experience back to the campus. Second, the design highlights how knowledge is not fixed but produced, in the interaction between people. In the wiki, everything that is written is immediately visible both to other students and to their university teachers, and students are then able to see how the experiences, thoughts, and texts of others develop over time. In addition, those involved can both learn from and contribute to the development of other students. In this development project, both collaborative technology and a principled pedagogical approach have afforded a design for learning trajectories and environments.

Conclusion

Throughout this paper, we have sought to show that increasingly complex learning environments require responses that go beyond what teacher education currently offers. Our contribution is to establish an understanding of digital technology as an artifact with transformational potential, linking this to the CHAT approach—a theoretical perspective that allows for transformation by theorizing the relationship between agents and artifacts while taking institutional dimensions into consideration. Together, these efforts bring us to the notion of design in teacher education. Two cases were used as empirical carriers to visualize the conceptual and theoretical underpinnings of the paper. The wiki case highlights artifact-mediated collaborative approaches to teacher education, while the digital exam shows how a campus teacher design is appropriated and transformed as the student teachers' designs seek through their learning to accomplish the object of the exam: an integrated view of subject knowledge, pedagogy, didactics, and practice. The example of a radically new exam type shows that doing design is something that should not just be *taught* but also *lived*. While design is not restricted to technology-rich learning situations, we argue, on the basis of a conceptual and empirical analysis, that a design approach can contribute to enhancing the quality of teacher education by specifying more closely what professional ICT competence can entail.

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