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RESEARCH

Producing Digital Learning Resources (DLR) for Teacher Training

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The purpose of this article is to describe the development and design process of an educational app for teacher training. Online teaching and learning resources are used more than ever in teacher training. However, the utilization of digital technology in higher education shows unambiguously that very little has been transformed or improved so far (Selwyn, 2014: 109). Regarding teacher education specifically; the slow uptake of ICT is also documented (Tømte, 2015: 151). Using a design-based research methodology, the researchers were involved in planning, designing and developing new resources for new practices in flexible teacher-training studies. Through three iterative cycles, the main aim in this article is to describe aspects in the process of designing DLR for the hybridization of teacher training. The findings suggest several aspects of the design process that we believe can enhance teacher trainers and development of digital learning content in higher education.

Keywords: Teacher training; digital learning resources; design

Introduction

Several teacher training institutions offer decentralized and part-time teacher-training studies. Use of digital learning resources is crucial to implement this kind of teaching in a satisfactory way. There are high expectations about the potential of digital learning resources in teaching, learning and assessing online in higher education (Johnson et al., 2016) and students entering higher education today expect flexible studies (Dahlstrom and Bichsel, 2014). Transformation of education is complex and takes place in small steps (Lund and Eriksen, 2016: 69). Involving teachers and development of pedagogical software have for decades, been a challenge in Norway, particularly for teacher education. We have to rethink how we offer learning. Students will not come to campus to participate in traditional (one-way) lectures that could be distributed via the internet, but they will come to campus to participate in meaningful educational activities (Nilsen, Almås and Krumsvik, 2013; Jaggars, 2014). Focus on embedding pedagogical design into the open educational resource development process is a widely accepted trend (Miao, Mishra, & McGreal, 2016: 225). Here we see a concrete need for developing new practices with the use of modern digital learning resources. Using scenario-based simulations tends to be successful for student teachers learning classroom management, "in providing leverage for reflection, by means of catering for social interaction and discussion during and after simulation sessions (Arvola et al., 2018: 111). But 'teachers are often introduced to digital educational resources that were developed in contexts different to their own' and as 'a consequence, significant analytical work is required to interpret the meaning potential of these resources and adapt them for use in local settings' (Hermansen, 2017: 2).

This article describes development of a digital learning resource in the national subject *Pedagogy and Pupil-related Skills* (PEL) (15 ECTS) for student teachers' professional development. In this design process, we involved teachers in an analytical manner as suggested by Hermansen. The development was part of the *Teacher for one day* – a project (2016–2017) that developed new resources for innovative practices in flexible teacher-training. The project focused on authentic cases and aimed to embed them in an online solution suitable for student teachers. In this perspective, there were few relevant comparison studies (Stålbrandt, 2013: 18). This article uses the *Teacher for one day* as point of departure. The main aim of this article is, through our development experiences, **to describe aspects in the process of designing DLR** for the hybridization of teacher training.

Theoretical lenses

This project is anchored in a sociocultural approach to teaching, reasoning and learning. This is a suitable framework through which we want to understand the complex interactions between learners, teachers and the resources that are used. The sociocultural perspective has reframed learning and development as the ability to participate in different social practices. A broader interpretation of

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knowledge and teaching requires a perspective that sees teaching and learning as taking place in a very complex educational ecosystem (Shear, Gallagher and Patel, 2011: 12; Kirschner, 2015: 314). The project is also embedded in a culture of participatory design. Users need to be actively engaged in the design process for using technology in learning, to ensure that it meets their needs and to ensure that there is ongoing engagement by all stakeholders (Scanlon, 2010). In addition to the complexity of learning situations, 'technology enhanced learning (TEL) requires interdisciplinary collaboration across the disciplines of learning, cognition, information and communication technologies (ICT) and education, and broader social sciences' (Scanlon, 2010: 4). When the dynamics of interaction between communication, technology and daily activities change, it provides opportunities to build new learning environments within the class, but also outside its four walls.

This defines the basis which we shall integrate into our debate about hybridization (Nilsen and Almås, 2016). What kind of learning resources should be offered (online, on- or off-campus), by whom and at what time? In an attempt to solve this, we must have a solid pedagogical framework into which technology can be incorporated. Laurillard's conversational framework (2002) describes an optimal learning process where teachers and students need to talk to each other and exchange ideas, where teachers set tasks for students, where learners need opportunities to put ideas into practice, and where learners need to reflect on what happens during their attempts to complete tasks. These are the core elements of an instructional process involving teachers, students and technology and builds a framework for thinking about the design of learning and teaching (Laurillard, 2009).

Methods and data

The *Teacher for one day* project is developing digital learning resources, which re-frame teacher training. The underpinning methodology for this project is design-based research (DBR) (Wang and Hannafin, 2005), which integrates design, theory, and practice through iterative actions and processes. This approach will serve as a continuation of our theoretic lenses when focusing on 'understanding the messiness of real-world practice, with context being a core part of the story and not an extraneous variable to be trivialized' (Barab and Squire, 2004: 3). Wang and Hannafin (2005) define design-based research as 'a systematic, but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real world settings, and leading to contextually-sensitive design principles and theories' (pp. 6–7).

In this research, we use three iterative cycles to analyze, design, implement and redesign (Wang and Hannafin, 2005). Each cycle integrates needs assessments, design solutions, testing, refining, reflecting and documenting. The data collected and analyzed in each cycle form the basis of the next cycle and bring implications for the next step in the design process (**Table 1**). As design-based research involves flexible design revision, multiple dependent variables, and capturing social interaction (Barab and Squire, 2004: 3), the data were collected from focus group interviews, minutes of meetings, design documents (sketches, manuscripts, test reports) and field notes. The focus group responses were immediately noted for further analysis. Three researchers involved in the meeting made their notes and wrote a final report. Both minutes of meetings and interviews were member checked by involved researchers and informants. In the analysis, the researchers condensed the views expressed by the informants (from minutes of meetings and interviews) into shorter formulations and, using meaning categorization, the interviews were coded into categories (Kvale and Brinkmann, 2009) and related to the development in each cycle. Our research was carried out in a real-life setting in Norway with collaboration between experienced practitioners and researchers from 7 departments in 5 different

Table 1: Overview of iterative cycles.

cycles	methods	aims	participants
1: Initial project draft	– examine the literature – identify gaps, dilemmas and existing problems – summarize experiences	– propose a concept/solution	– teacher trainers – online learning experts – a total of 4 persons
2: Develop a storyboard	– collaboration between practitioners and researchers – analyzing process-documents, prototypes, mind-maps – physical workshops	– agree on sketch of the content, ready for further scriptwriting and implementation	– teacher trainers – teachers in a primary and a secondary school – online learning experts – digital development team (graphic designer, copywriter, technical development) – a total of 10 persons
3: Implementation phase	– collaboration between practitioners and researchers – dialogues – analyzing and testing prototypes	– an app ready for distribution	– teachers trainers – digital development team – video production team – a total of 13 persons

institutions (technical production (2), teacher education/pedagogy (2), primary school (1), secondary school (1), and educational research (1)).

When it comes to handling of personal information, and the quality assurance of our ethical process NSDs (Norwegian Centre for Research Data/Data protection services) regulations have been followed. In carrying out interviews, observations and collection of documents, our empirical data is recorded exclusively in the form of notes. No names and no personally identifiable background information is registered in the data material. The information can in no way be traceable to individuals.

Iterative cycles

Design-based research (DBR) is grounded in real-world contexts where participants interact socially with one another, because it considers the role of social context having better potential for influencing educational practice (Barab and Squire, 2004: 2). With DBR as point of departure, we conducted three iterative cycles of research and development around our mission to describe aspects in the process of designing DLR for teacher training (**Table 1**).

Participants and context

Several practitioners and researchers were involved in the process. As Scanlon (2010) suggests: 'the design and evaluation of teaching material requires a multidisciplinary approach working as a team with a range of complimentary expertise' (p. 4). Across the three iterative cycles of research and design in this project, 14 people participated. The participants in Cycle 1 were 4 people from 2 institutions; Cycle 2 had 10 people from 6 different departments and institutions; and Cycle 3 had 13 persons from 7 departments and institutions.

Descriptions and results of the iterative design cycles

Cycle 1: Project draft

The first cycle aimed to propose a concept and solution for what kind of digital learning resources is suitable and recommended in our context. This cycle had 4 participants searching iteratively for a relevant concept for the project draft. Our findings in this cycle concentrated on three issues.

Current situation and needs

By reviewing status reports and White Papers we can document that Initial Teacher Education (ITE) in Norway is currently undergoing extensive changes. There has been an increase in online and part-time study alternatives (Ministry of Education, 2018). The change in National Curriculum Regulations and the development of flexible teacher education are essentially organizational changes linked to the structure and organizing of studies. This is fundamental change that is demanding in itself. However, this has led to a lack of focus on pedagogical development. Although descriptions of methods and tools are provided, which enhance the quality of online education, these contain few descriptions of how the content can be developed and adjusted.

Our own experiences

Through several meetings, experiences from our own professional environments were collected, summarized and discussed. The list of designs and productions show that the NettOp department at our partner university had specialized in designing, developing and producing digital games, MOOCs and apps for higher education since 2000. The pedagogical issues concerning how to orchestrate and compose the best blended solution where students are working individually, in groups and in plenary – both on- and off-campus – have been central in our research over the last decade (Anonymous, 2013). Still, a major challenge is to engage more teacher trainers in the use of DLR, which also enables them to participate in refining and developing new resources and practices.

Other relevant sources

An early idea in this project, documenting experiences from the process of designing a DLR, was to record authentic cases and embed them in a solution suitable for students in teacher training. A search for relevant research and projects, and examining these findings reveal few relevant comparison studies (Stålbrandt, 2013: 18). In her recent research, Stålbrandt presents previous research (Metcalf, Hammer and Kahlich, 1996; Dotger and Smith, 2009) when summarizing that video-recorded teaching is a common simulation, and that these can positively develop student teachers' professional reflections (Stålbrandt, 2013: 17). At the University of Oslo, we are familiar with use of video-recorded cases in connection to home examination. Anders Jönsson (2008) has documented similar experiences when he explored some of the problems associated with introducing authentic assessment in teacher education. Josephine Lang (2010) emphasizes that 'the use of vicarious and narrative experiences that can be afforded by new learning technologies can enhance professional learning of preservice teachers as they engage with its authenticity' (p. 15).

According to UNESCOs Open Educational Resources (OER) publication, 'creating awareness of OER, involving teachers and students in OER, and sustaining OER projects are seen as the major challenges in most cases' (Miao, Mishra and McGreal, 2016: 225). The *Teacher for one day* project is inspired by these projects. In addition, it aims to address new perspectives about: the link between teacher education, concerning skills and enhancement of competence, and innovation from staff about teacher education, by positing a closer and more holistic interrelationship between learning resources, methodology, practice and campus activities.

Results from cycle 1 and implications for design of cycle 2

Examining the literature and relevant available design cases during cycle 1, we established a foundation and addressed some contextual demands. As our experiences

document, we identified gaps and existing issues that indicate there is a need for focusing on digital content. Our findings showed that there is a lack of focus on pedagogical development and few pedagogical descriptions of how content can be developed and adjusted. The current situation and needs call for embedding the content in a way that fits both on- and off-campus study. Our own research and development experiences also suggest that more teacher educators need to be involved in the use and design of DLRs. Both Lang (2010) and Stålbrandt (2013) emphasize that use of authentic vicarious experiences, afforded by new learning technologies, can enhance the learning of pre-service teachers.

Analysis of cycle 1 calls attention to involvement (of practitioners and teachers in the teacher training) and selection of content. We need to examine the curricula and identify themes that can be presented as authentic cases with authentic dilemmas. This requires close involvement by subject teachers in teacher education, and from personnel with experience in online higher education.

Cycle 2: Storyboard

The main aim of cycle 2 was the selection of content and agreement on a sketch ready for in-depth scriptwriting and implementation. In this phase, our experiences with our department for the development of digital teaching materials and solutions for online education at the university were used. An online learning expert from our partner university led the script-writing process. The first task was to develop a storyboard based on what the learning outcome should be for each case. As cycle 1 emphasized authenticity, we involved teacher trainers to point out some dilemmas and problems for discussion from the subject Pedagogy and Pupil-related Skills (15 ECTS). Based on the dilemmas from the subject and the selection of content, we needed to identify the theme and the main character in the case. Four different teacher trainers were involved in working on the theme and content presented in the authentic cases. In addition, this cycle involved three experienced teachers from primary and secondary school. During iterative work in cycle 2, this team (n = 7) were in charge of the quality of content in the storyboard. The assignment in this cycle were focused on the *selection of content* and the *progress of the script*.

Selection of content

The next iterative step of cycle 2, and to achieve constructive cooperation between practitioners and teachers on the teacher training, we arranged several meeting opportunities and physical workshops, involving different participants in the design, to bring their unique expertise into producing and analyzing the design. This is an important characteristic of DBR (Barab and Squire, 2004: 4).

In cycle 2, our group of teacher trainers with professional expertise in pedagogy developed a list containing 10 dilemmas or themes based on challenges from the syllabus. During a quality assessment meeting with the reference group and the teachers in primary and secondary school, three of these ideas (dilemmas) were selected for further work. During this meeting, a first focus group interview (n = 6) was conducted using a semi-structured interview protocol. Themes identified from condensed interview notes and minutes from the meetings document perspectives, contributions and arguments from the participants concerning pros and cons for the elaboration of the ideas. The involved teacher trainers and project manager then further developed these ideas.

The progress of the script

Experienced teacher trainers were involved from the beginning and were capable of identifying elements from the syllabus that are important to reflect upon. After the clarifying workshops, the teacher trainers stepped into the role of script authors. Through several rounds of exchanging, mind-mapping, sketching and documenting, the process made progress. These maps and files were collected as part of the empirical material together with researchers' field notes. Following version control of the files, analysis of the development of these files unveil there were several obstacles to navigate, such as hypermedia scripts being a completely new genre to master, both to write and to read. We discovered that it was a complex process extracting the right topics and expertise from the teacher trainers into these scripts. Many questions arose, e.g. what about all the contextual improvisations, the tacit knowledge and experiences. Together with the produced files, the field notes documented that it was a challenging process to incorporate the subject theme, and lecturer's knowledge and competence related to it, into a textual script in compliance with the technical standards.

Again, a workshop with the reference group and the teachers in primary and secondary school were arranged and it was a valuable opportunity for iteration of the content. During this meeting, the second semi-structured focus group interview (n = 7) was conducted. Examining and generating the themes from condensed interview notes and minutes from the meetings, one particular issue emerged – the need for different expressions, formats and solutions for the three cases regarding the nature of the content.

Results from cycle 2 and implications for design of cycle 3

Forcing practical content with all variables into fixed frames was perceived as quite challenging for the professional people involved. The main objective in this cycle was the selection of content and agreeing on a sketch of the content for each case. The findings from the process revealed that there was consensus of opinion in favor of expressing both academic depth and authenticity. The cases needed to be distinct but also contain several interpretations and solutions. The themes from the teacher responses recommend every case should also include:

- an introductory video to inspire and emphasize the seriousness of the topic
- a closing movie which sums up and clarifies best practices regarding the topic
- multiple choice questions to test the theoretical syllabus

– reference list to articles, literature, and other relevant learning resources

Cycle 3: Implementation

The aim for cycle 3 is to prepare an app distributable through App Store and Google Play. The main activities here were the production and implementation of visual elements, dynamics and functionality in the technical platform. A digital production team consisting of professional experts (programmer, designer, director and photographer) were responsible to fulfil these work packages. They produced the visual interface, video material, still photos and voice over. Finally, a programmer put it all together. All of this was a participatory process, still in close cooperation with the teacher trainers. The findings from this cycle are mainly derived from minutes of meetings, field notes and prototype files.

Going from imaginary thoughts to a concretized app

A wide range of participants were involved in cycle 3. A crucial and exciting step in this cycle is when the authors' stories go from personal, imaginary thoughts, to a common, concretized case story. When a photographer and a director interpret, shoot and document your story, will they catch the main points and the whole story? Will the hidden links, info, dilemmas and contextual knowledge be visible? Will they create a representative and authentic universe? During the production phase, we were preoccupied with these questions.

Launching the alpha- and beta-versions of the app from the digital development team, the teacher trainers (n = 4) met for workshops with the project manager and researchers as quality assurers. During dialogue around prototype (stills, video and app-sketches) testing and re-writing scripts, we reached a consensus to be implemented.

Findings from cycle 3

When crystallizing into faces, voices, images and videos in a designed display, a new energy entered the process. Moving the case descriptions and learning content from the teacher trainers into the hands of the photographers and programmers, revealed that important clarifications were necessary to achieve the desired result. For teachers and teacher trainers, details in display design and programming is out of their area of competence. Nevertheless, the findings generated from workshop dialogues (field notes), test reports and prototype files in this cycle show necessary interest in these details:

Buttons and menus

- What kind of choices are available when it comes to interface and navigation? The content was implemented in an app (for smartphones and tablets). Due to experiences and progress, the learning cases were embedded in a fixed layout used before. For the non-technicians this was a new mindset. When producing content for a small screen there are limitations when it comes to size of pictures, length of texts and modes of interaction.

The graphical elements, illustrations, audio and video material

- It is essential for the cases that the learning content is presented and communicated in a way that represents the dilemmas correctly. This is both effectual and challenging when using formats like audio, and video, which involve feelings and emotions.
- Humans interpret audio, images and video differently. Concerning this, working with such details in cycle 3 helps to visualize, verbalize and analyze competence and tacit knowledge in classroom situations.

Discussion

This article aims to describe aspects in the process of designing DLR for the hybridization of teacher training. According to the introduction and theoretical aspects presented, three iterative cycles were framed by design-based research to focus our discussion and contribute to developing new educational resources. We frame our arguments in the broader ecology of education (Kirschner, 2015: 320). Because of increased complexity when adding technology to learning situations, this development is performed through an interdisciplinary collaboration across the disciplines of learning, cognition, information and communication technologies (ICT) and education (Scanlon, 2010: 4). In this article teacher education is the focus of attention with its slow uptake of ICT (Tømte, 2015: 151). Kirschner asks for more research in the field were teachers are designers of technology-enhanced learning (Kirschner, 2015: 320).

Cycle 1: Engaging staff from teacher training in modernizing education through the development of DLR

There is a research gap and a need for developing new pedagogies that respond better to the dynamics of the 21st century learning (Scott, 2015). Miao et al. (2016) describe the potential for educational resources: 'it can help teachers create an engaging classroom'. In this, 'there is also a potential for transforming students' roles in learning and engaging them in making sense of real world challenges' (p. 225). For the future, we 'need student teachers who can design new practices with ecological validity for a changing world' (Lund and Eriksen, 2016: 69). The socio-cultural perspective is based on a constructivist view of learning, and attaches crucial importance to knowledge being constructed through interaction and not primarily through individual processes. Consequently, the first cycle points to the importance of engaging teacher trainers in their teaching activities and subjects with the development of digital learning resources (DLR). Findings from our own research and development experiences suggest that more teacher educators need to be involved in use and design of DLRs. According to Scanlon (2010), 'users need to be actively engaged in the design process for using technology in learning to ensure that it meets their needs' and to ensure that there is ongoing engagement by all stakeholders. Our initial iterations in this cycle show a common understanding identifying gaps that indicate there is a need for focusing digital tools and educational

content and resources. There is also agreement that we have to embed the content in a way that fits both on- and off-campus study.

To develop content in the rigid frames of an interactive case also challenges the way the teachers prepares their classes and their teaching. During cycle 1, the teacher trainers and developers involved came to learn about the potential and boundaries of both the content and technology. At the same time the question arose about how the students and their teachers should work with the cases throughout their study; alone or in groups, before or after class, face-to-face or online, and on- or off-campus. Interactions are central to the present sociocultural pedagogy and Vygotsky points out that knowledge depends on the culture of which it is a part. Knowledge never exists in a vacuum; it is always 'situated', which means that knowledge is entrenched in a historical and cultural context. Consequently, the development of DLR has to be situated in the daily life of students and trainers, and for this reason, cycle 1 constitutes reflection concerning a revised learning and teaching design related to a social, interactive and cultural context.

As a continuation and to operationalize the sociocultural approach, the discussions had moments highlighted in Laurillard's conversational framework (2002). The iterative discussions of the pedagogical scenarios included Laurillards's four kinds of communication forms: discussion, adaptation, interaction and reflection. The development group from cycle 1 stated that optimal learning processes are where teachers and students need to talk to each other; where teachers set tasks for students, and learners need to reflect on what happens during their study tasks. Findings in this cycle ascertain that the DLR described requires distinct framing and facilitation by teachers in teacher education. During the investigation of the app-concept, it was obvious that this can be done in different ways. The content and the structure of the app forms the core. The teacher can start teaching traditionally with a plenary lecture on campus, then the students can be guided to use the app for individual, pair or group activities. To conclude, teachers and students can bring their experiences, memos and reflections to physical plenary gatherings. This thinking emphasizes the sociocultural context and builds on the results in Stålbrandt's study, which point out that student teachers' understanding of learning, and teaching is supported when authentic narrative experiences can be offered through new flexible technology combined with dialogue with other resources (Stålbrandt, 2013: 29).

Findings documenting the current situation and need for DLR in our context of higher education call for embedding the content in a more modern and digital way that fits online learning activities. According to the Vygotskian (1978) perspective regarding knowledge being interactively constructed by artifacts, we have to include the tools of the culture into which the students and teachers are born. Digital learning resources like apps for smartphones and tablets are considered as tools of our culture. The research from Lang (2010) and Stålbrandt (2013) concretize some implications for design of digital resources and didactic processes in teacher education. They call attention to the need for more research focusing on the connection between schools and higher education, methods to support the development of student teachers' reflectivity and the development of multifaceted flexible digital learning environments where the qualities in a narrative approach are utilized in the design to develop professional skills (Stålbrandt, 2013: 29).

The findings show that there is a lack of focus on pedagogical development and few pedagogical descriptions of how the content in DLRs can be developed and adjusted. Cycle 1 revealed an engagement for relevant cases and a need for assuring the quality of our ideas with a reference group of teachers from primary and secondary school. This documents the demand for a holistic perspective of the ecology of teacher design knowledge. Emphasizing the interactions between elements includes the relationships between different kinds of knowledge described: know-what, know-why, know-how, know-when, know-who. This includes cross-disciplinary thinking around issues related to 'yielding powerful design heuristics, emphasizing teacher-designer consciousness and situated experience, and generating realistic understanding of design practices' (McKenney et al., 2015: 198).

Through the dialogue and minutes of meetings, cycle 1 documents an engagement from involved teachers and teacher trainers. The analysis of collected data from cycle 1 calls attention to selection of content and customizing for desired formats. Such work processes require involvement from personnel with experience in online higher education.

Cycle 2: Selection of content and development of storyboards

The concept prepared in the first cycle advocates use of images and video to present the content. Using video to support in-service teacher professional development is increasing, and Major and Watsons (2018) review shows that using video in teacher professional development 'is extremely promising' (p. 65).

Jonassen and Hernandez-Serrano (2002) describe case-based reasoning as a method for eliciting and making stories available as instructional support for learning to solve problems. First, it is necessary to elicit and capture relevant stories about previously solved problems from the practitioners, in this case teacher trainers. In each case, relevant research, syllabus, learning outcomes and the situation were examined to include only the kind of information relevant to the solution. To assure the collection and to confirm the best authentic stories, teachers from primary and secondary school were involved in a reference-group workshop. 'Collecting stories from experienced practitioners will provide relevant information that can be used for interpreting and understanding problem-solving tasks in order to design instruction' (Jonassen and Hernandez-Serrano, 2002: 71). Findings from the first focus group interview document practitioners' experience, their arguments and selection of content for the app (DLR).

In developing a storyboard ready for in-depth script-writing and implementation, we outlined our views about

what it means to learn. According to the theoretical perspectives, we are framing our learning as a process where teachers and students talk to each other (Vygotsky, 1978; Laurillard, 2002), where teachers set tasks for students, and where learners have opportunities to put ideas into practice and can reflect on what happens during their attempts to successfully complete tasks. This concept contains a number of dilemma-oriented and open-ended cases. Then students are expected to make reasonable assumptions, to judge alternative interpretations and take action. Forbes et al. (2016) imply that resources that are efficient in instigating a feeling of social presence may lead to deeper learning and that multimedia which communicate 'with the learner directly and informally using narratives from a first-person point of view were more efficient in engaging students cognitively and socially' (Forbes et al., 2016: 54). Themes identified from condensed interview notes and minutes from the meetings document perspectives and contributions from the participants for the elaboration of the learning content. We discovered that it was a complex process extracting the right topics and expertise from the teacher trainers into these storyboard scripts. Our findings in cycle 2 concerning content-selection confirm Jonassen and Hernandez-Serranos (2002) statements that this is demanding and that the advice available is insufficient. Findings from the second focus group interview and field notes, showed especially one issue was discussed: the need for different expressions and solutions for the three cases regarding the nature of the content. Because of this, and trying to instigate feelings and empathy our three cases were presented in different ways within the framework of our app.

The process of the second cycle illuminates tensions when it comes to the role of a learning resource. The awareness of the content and the way of working with learning in the app were frequently deliberated. This implicates the learning outcome. The empiric material contained our respondents' different views and perspectives concerning teaching and learning. This represents an educational culture which allows teachers to be autonomous. The aspect that reconciles the informants with each other is, interestingly, their sociocultural focus on interactive dialogue between students, teachers and the DLR-content. Still, an unanswered question in this cycle is to what extent the app should be responsible for the total learning outcome.

Continuous discussion during this cycle related to issues of a new format and a fixed layout. The findings indicate that this process serves as a catalyst for the necessary revision the teacher is confronted with. This app and these design iterations may be tools for the teacher trainer in his/her revision of his/her teaching. This confirms previous research implying that new technological opportunities embedded in the design of learning environments, make teachers rethink their practice, try new things and explore creative alternatives (McKenney et al., 2015: 184).

Cycle 3: Implementation and transformation of imaginary thoughts into an app

When describing a framework to support the work of teachers as designers of technology enhanced learning, McKenney, Kali, Markauskaite & Voogt (2015) emphasize the complex competence needed, and the knowledge teachers appear to have and/or need for designing. The case developers (teacher trainers) consider these complex ecological perspectives, which for some teachers are their tacit knowledge, when designing the case manuscripts. By using the sociocultural perspective as a framework, we identified how respondents developed their knowledge. In this cycle of designing DLR there were dialogues for verbalizing and exchanging knowledge. Themes from the minutes of meetings show how informants' challenges related to the design process were discussed and how their common knowledge is constructed through the practical activity of cycle 3 where groups of people interact within a cultural community. The concrete representation of the DLR was accelerating these discussions and both findings from cycle 2 (discussing content and expressions) and cycle 3 (quality checking) indicate how this can facilitate teachers' reflections on their own teaching.

Our findings from cycle 3 show that moving the case descriptions and learning content from the teacher professionals into the hands of the photographers and programmers reveal important clarifications to be made to achieve the desired result. The teacher trainers were involved to assure both that the story is correctly understood and that it is well defined and presented. Even if this consensus is achieved, the next barrier is to document the story in the available school context with real teachers and pupils.

Cycle 3 also reveals that, for teacher trainers, details in the display design and programming is out of their area of competence. The learning cases were embedded in a technical template used before. As a result of that, there was a need for adjustments, additional functionality and more space – details related to the interface and architecture of the template. What does the app provide the students with to process the content in their learning? And how to facilitate assessment? All of these are traditional pedagogical issues that, through discussions in the iterations result in new perspectives on learning and our thinking about teaching – and in sum are illustrating the teachers' holistic ecological perspective (McKenney et al., 2015: 190). The process of intertwining the teacher professionals learning content and didactics, and developers and photographers trade to ensure success was the main aim of cycle 3. Teachers formulated the narrative and wrote the case manuscripts. The authors created the dilemmas and its pupils in their own fictional story, but will the developers manage to transform this visually? We were aware, as Forbes et al. (2016) were, that resources that instigate empathy and social presence may lead to better learning. The perception is created using words, images, audio, gestures, expressions and atmosphere and we succeeded differently in each case when it comes to transfer of content for reasons related to these effects.

Starting with the fact that we all perceive real situations differently, cycle 3 helps to visualize, verbalize and analyze competence and tacit knowledge in classroom situations. During cycle 1, this concept was designed to be open to more than one interpretation. In that case, it will clear

the way to reflection and discussions among the students, beyond the described alternatives in the app.

Conclusions

By developing and adopting digital learning resources in hybrid teacher-training studies, the aim of this paper is to describe aspects in the process of designing DLR for the hybridization of teacher training. The iterative cycles of testing and refining (Barab and Squire, 2004, Wang and Hannafin, 2005) produced new knowledge, which is applicable for future projects. In terms of participatory design, context and competence we identify aspects that will support the teacher in their work, moving learning content from campus to other arenas, and to offer motivating, diverse, practical and authentic education to students in their teacher training. Anchored in hybrid teacher education and development of a DLR, throughout three iterative cycles we describe design objectives, implications and our solutions. When combining online and campus activities, integrating digital resources, a critical area requiring further discussion and research is the understanding of how online communities and resources function (Harasim, 2012), and the analytical work required to adapt and interpret the potential of these resources for use in local settings' (Hermansen, 2017: 2). Findings from the cycles described contribute to this missing research area (Harasim, 2012; Hermansen, 2017).

Our initial cycle aimed to propose a concept draft for digital educational content. Our findings strengthen previous research (Scanlon, 2010; Stålbrandt, 2013), and this phase was useful regarding developing competence and to elucidate and agree on how students and their teachers should work with the cases throughout their study; alone or in groups, face-to-face or online, and on- or off-campus. This cycle constitutes necessary reflections concerning a revised learning and teaching design – and involvement from teacher professionals was decisive in choosing suitable content and framing.

The second cycle should agree on a sketch and a storyboard. The main work here was to choose and present content in accordance with the syllabus and which was important for students to practice before they leave campus. There are no quick-fixes at this stage (Jonassen and Hernandez-Serrano, 2002). To satisfy the learning content and the feelings and empathy involved it was necessary to present the content in different ways within the framework of our app. Because of the discussions concerning issues of a new format and a fixed layout we can suggest that, this iterative design cycle functions as a tool for the teacher trainer in his/her revision of their own teaching.

The realization of cycle 3 revealed the importance of intertwining teacher professional competence and details in the display design and programming. For the teachers to be competent designers of learning, they need to be recognized as experts in the domain in which they teach, in the art and science of learning and teaching, and in the science of research and design (Kirschner, 2015: 321). The fixed template needed functions that are flexible. Through the interdisciplinary discussions in the cycle the teachers' holistic ecological perspective were illustrated.

The main success factor is the involvement of the teacher trainers, as subject matter experts, from start to finish in the project. The teacher trainers are then involved in all phases of the production: throughout scriptwriting, development and testing. Development of new educational practice takes time. The use of technology in teaching is controversial in higher education and there are many opinions about how it should be used. Systematic and structured work with testing and sharing of new tools is important. Our experience during this project is the importance of having a concrete resource that teachers can participate in developing and testing.

As a summary of the process of designing DLR for the hybridization of teacher training, we will emphasize some aspects for designing digital learning resources that include:

- The importance of each stage of the design process (concept drafting, storyboarding, and final design).
- The importance of involving practitioners in each and every stage of the design process.
- The roles played by the various participants and the importance of an interdisciplinary approach.
- The possibilities that such a design process, developing a concrete resource, offers for professional development of the teachers involved themselves.

Through our analysis of the development process and discussion of these points, it is reasonable to suggest that such a process can also improve the teacher educator and the use of DLR. Laurillard argues that 'the academic should be seen not just as researcher and teacher of their subject, but also as researcher into the teaching of their subject' (2002: 217). With the teacher trainers (academic) playing this kind of role in a process of designing DLR, problematizing their teaching and students' learning in the context, the university will be developed as a learning organization right through to the course level.

In our article, we strive to advance a particular set of aspects that transcends the environmental particulars of the contexts in which they were generated. However, for this to be reasonable and useful warrants for advancing assertions, one must be aware of the limitations of the findings. Our findings and conclusions are limited to a process in a local context. In addition, we acknowledge that as researchers, we are 'intimately involved in the conceptualization, design, development, implementation, and researching of a pedagogical approach', and that ensuring that we can make credible and trustworthy assertions then is a challenge (Barab & Squire, 2004: 10).

We cannot be sure if we have managed to capture all of the informants' thoughts in such a process, and all the details that explain what made them so. Nevertheless, by describing the context and how we, through several empirical methods, synthesize findings and connect them theoretically – our conclusions may transcend the local context. With this understanding, this study is presented in order to promote further discussion and research about producing digital learning resources for teacher training.

The contribution of our design-based research study is in informing technologically-enhanced designs for teacher training in a hybrid learning situation. This study highlights several aspects of the design process that we believe can enhance teacher training and development of digital learning content in higher education.

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Competing Interests

The authors have no competing interests to declare.

References

Arvola, M., Samuelsson, M., Nordvall, M., & **Ragnemalm, E. L.** (2018). Simulated Provocations: A Hypermedia Radio Theatre for Reflection on Classroom Management. *Simulation & Gaming, 49*(2), 98–114. DOI: https://doi.org/10.1177/1046878118765594

Barab, S., & **Squire, K.** (2004). Design-Based Research: Putting a Stake in the Ground. *The Journal of Learning Sciences, 13*(1), 1–14. DOI: https://doi.org/10.1207/s15327809jls1301_1

Dahlstrom, E., & **Bichsel, J.** (2014). *ECAR Study of Undergraduate Students and Information Technology, 2014*. Louisville: EDUCAUSE.

Dotger, B. H., & **Smith, M. J.** (2009). "Where's the Line?" – Negotiating Simulated Experiences to Define Teacher Identity. *The New Educator, 5*(2), 161–180. DOI: https://doi.org/10.1080/1547688X.2009.10399570

Forbes, H., Oprescu, F. I., Downer, T., Phillips, N. M., McTier, L., Lord, B., ... Visser, I. (2016). Use of videos to support teaching and learning of clinical skills in nursing education: A review. *Nurse Education Today, 42*, 53–56. DOI: https://doi.org/10.1016/j.nedt.2016.04.010

Harasim, L. (2012). *Learning theory and online technologies*. New York: Routledge. DOI: https://doi.org/10.4324/9780203846933

Hermansen, H. (2017). Knowledge relations and epistemic infrastructures as mediators of teachers' collective autonomy. *Teaching and Teacher Education, 65*, 1–9. DOI: https://doi.org/10.1016/j.tate.2017.03.003

Jaggars, S. S. (2014). Choosing Between Online and Face-to-Face Courses: Community College Student Voices. *American Journal of Distance Education, 28*(1), 27–38. DOI: https://doi.org/10.1080/08923647.2014.867697

Johnson, L., Becker, S. A., Cummins, M., Estrada, V., Freeman, A., & **Hall, C.** (2016). *NMC Horizon Report: 2016 Higher Education Edition*. Austin: The New Media Consortium. Retrieved from http://cdn.nmc.org/media/2016-nmc-horizon-report-he-EN.pdf

Jonassen, D. H., & **Hernandez-Serrano, J.** (2002). Case-based reasoning and instructional design: Using stories to support problem solving. *Educational Technology Research and Development, 50*(2), 65–77. DOI: https://doi.org/10.1007/BF02504994

Jönsson, A. (2008). *Educative assessment for/of teacher competency. A study of assessment and learning in the "Interactive examination" for student teachers*. Malmo: Malmö University. Retrieved from http://dspace.mah.se/dspace/bitstream/handle/2043/6182/educative_assessment_kappa.pdf?sequence=1

Kirschner, P. A. (2015). Do we need teachers as designers of technology enhanced learning? *Instructional Science, 43*(2), 309–322. DOI: https://doi.org/10.1007/s11251-015-9346-9

Kvale, S., & **Brinkmann, S.** (2009). *Interviews: learning the craft of qualitative research interviewing*. Los Angeles: SAGE.

Lang, J. (2010). Significance of a multimedia resource in the professional learning of preservice teachers. In S. Howard (Ed.), *AARE 2010: Proceedings of the 2010 Australian Association for Research in Education Conference* (p. 18). Melbourne: AARE.

Laurillard, D. (2002). *Rethinking university teaching: A conversational framework for the effective use of learning technologies* (2 ed.). London: RoutledgeFalmer. DOI: https://doi.org/10.4324/9780203304846

Laurillard, D. (2009). The pedagogical challenges to collaborative technologies. *International Journal of Computer-Supported Collaborative Learning, 4*(1), 5–20. DOI: https://doi.org/10.1007/s11412-008-9056-2

Lund, A., & **Eriksen, T. M.** (2016). Teacher Education as Transformation: Some Lessons Learned from a Center for Excellence in Education. *Acta Didactica Norge, 10*(2), 53-72. DOI: https://doi.org/10.5617/adno.2483

Major, L., & **Watson, S.** (2018). Using video to support in-service teacher professional development: the state of the field, limitations and possibilities. *Technology, Pedagogy and Education, 27*(1), 49–68. DOI: https://doi.org/10.1080/1475939X.2017.1361469

McKenney, S., Kali, Y., Markauskaite, L., & **Voogt, J.** (2015, March). Teacher design knowledge for technology enhanced learning: an ecological framework for investigating assets and needs. *Instructional Science, 43*(2), 181–202. DOI: https://doi.org/10.1007/s11251-014-9337-2

Metcalf, K. K., Hammer, M. A., & **Kahlich, P. A.** (1996, Mai). Alternatives to field-based experiences: The comparative effects of on-campus laboratories. *Teaching and Teacher Education, 12*(3), 271–283. DOI: https://doi.org/10.1016/0742-051X(95)00037-K

Miao, F., Mishra, S., & **McGreal, R.** (Eds.) (2016). *Open Educational Resources: Policy, Costs and Transformation*. Paris: UNESCO/Commonwealth of Learning. Retrieved from http://unesdoc.unesco.org/images/0024/002443/244365e.pdf

Ministry of Education. (2018). *Tilstandsrapport for høyere utdanning 2018*. Oslo: Ministry of Education. Retrieved from https://www.regjeringen.no/contentassets/eb4e02ae65134e42bba060e879536675/

oppdatert-publiseringversjon-tilstandsrapport-2018.pdf

Nilsen, A. G., & **Almås, A. G.** (2016, December 31). Added Values and Challenges Social Media Represent in the Hybridisation of Teacher Training. *European Journal of Open, Distance and E-Learning*, 75–87.

Nilsen, A. G., Almås, A. G., & **Krumsvik, R. J.** (2013, June 18). Teaching Online or On-Campus? – What Students Say About Desktop Videoconferencing. *Nordic Journal of Digital Literacy, 8*(01–02), 90–106.

Scanlon, E. (2010). Technology enhanced learning in science: interactions, affordances and design based research. *Journal of Interactive Media in Education*. DOI: https://doi.org/10.5334/2010-8

Scott, C. L. (2015). *THE FUTURES of LEARNING 3: What kind of pedagogies for the 21st century?* Paris: UNESCO Education Research and Foresight. Retrieved from http://unesdoc.unesco.org/images/0024/002431/243126e.pdf

Selwyn, N. (2014). *Digital Technology and the Contemporary University. Degrees of digitization*. London: Routledge. DOI: https://doi.org/10.4324/9781315768656

Shear, L., Gallagher, L., & **Patel, D.** (2011). ITL Research 2011 Findings: Evolving Educational Ecosystems. In *ITL research, Innovative Teaching and Learning Research. 2011 Findings and Implications*, 9–29. Menlo Park: ITL research/SRI International.

Stålbrandt, E. E. (2013). *Simulerade skoldilemman – redskap för utveckling av reflektionsförmåga?* Åbo: Åbo Akademi University Press. Retrieved from http://www.doria.fi/bitstream/handle/10024/88876/edman_eva.pdf?sequence=2

Tømte, C. E. (2015). Educating Teachers for the New Millennium? Teacher training, ICT and digital competence. *Nordic Journal of Digital Literacy*, 138–154. Retrieved from http://www.idunn.no/ts/dk/2015/Jubileumsnummer/educating_teachers_for_thenew_millennium_-_teacher_traini

Vygotsky, L. S. (1978). *Mind in society: The development of Higher Psychological Processes*. London: Harvard University Press. DOI: https://doi.org/10.2307/j.ctvjf9vz4

Wang, F., & **Hannafin, M. J.** (2005, December). Design-Based Research and Technology-Enhanced Learning Environments. *Educational Technology Research and Development, 53*(4), 5–23. DOI: https://doi.org/10.1007/BF02504682

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