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Learning with digital technologies in higher education

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Abstract

This exploratory research study proposes the notion of learning ecologies, as a space for learning where students can navigate to find knowledge by engaging with digital-material technologies. The study engages in a conceptualization of learning wherein the students are viewed as active participants, who seek knowledge and resources also outside the course contexts. The study explores this assumption in the empirical context of two higher education courses, in software engineering and teacher education. The analyses of the qualitative data indicate that digital-material tools are a *part* of the students' learning processes and shape the way they act and learn during the activities. The study proposes that pedagogical practice in higher education gives better consideration to how digital technologies can be embedded in the formal learning environments and connects students to various sites for learning.

Keywords: higher education; student learning; learning ecologies; digital technologies; qualitative research

1. Introduction

In recent years, higher education programs are challenged to prepare students to be competent knowledge workers. This implies ambitions for students to develop capacities to process, assess and employ knowledge, often to be found outside the formal course contexts (Shaw et al., 2011). This implies that learning can emerge at the crossroads between formal education settings and other contexts (e.g., professional, personal), characterized by curricular crossovers between scholarly knowledge and professional practices (Damşa & Jornet, 2016). Generally, there is wide agreement that such activities can be beneficial for students' later involvement in knowledge work and study programs are, progressively, including this type of learning activities in their curricula. Recent studies (Aditomo et al., 2013; Lang & Siemens, 2017) indicate, however, that meaningful participation in learning activities that involve navigating various contexts in order to access knowledge and using digital tools to do so is not a straightforward matter. Hence, more research is needed to understand and be able to support students' engagement in this type of learning

This study examines software engineering and teacher education undergraduate students' learning activities in situations that go beyond their institutional course contexts, and where digital technologies play an important role in supporting the learning activities students are involved in. In a Norwegian context, both teacher and software engineering education are seen as high priority sectors. National regulations for teacher education note that the guidance and assessment of the pre-service teachers' learning during their teaching practice period should be ensured by school mentors but also by university staff (KD, 2016-2017). These expectations may appear straightforward, but studies have shown that sustained guidance, seen as important for students' knowledge and competence development, is not easily achieved (Hill &

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Grossman, 2013). In *software engineering*, the knowledge content students must learn is geographically dispersed and often represented in online resources (professional databases and forums) (Nerland & Jensen, 2010). In this context, for students, the challenges emerge to understand that these resources are available and where, and develop the ability to apply key technical skills and digital tools to engage in authentic engineering projects (Litzinger, Hadgraft, Lattuca & Newstetter, 2011).

The challenges described here are both of practical and academic nature, such as: a) the multiple sites at which learning takes place, i.e., on campus, online/in learning management systems, in internship schools; b) i.e. the complexity of the practices to be learned, which require sustainable guidance from teachers; or c) the need to employ various digital technologies necessary to manage this processes. This exploratory study takes into account the volatility of these learning situations, with students facing the challenges of the increasingly versatile technologies that generate new opportunities and challenges for learning.

2. Theoretical perspectives

Contemporary learning is no longer viewed as the mastering of a given subject, but involves being knowledgeable across a variety of contexts, with the ability to (employ tools in order to) connect to remote knowledge resources, communities and sites no longer bound to one particular physical context (Carvalho & Goodyear, 2015). Students are placed in situations that require deliberate engagement and sustained efforts to navigate these hybrid learning environments and construct own learning ecologies. I, therefore, adopt an ecological perspective (see Damşa & Jornet, 2016) to learning, in line with recent sociocultural conceptualisations that view digital-materials resources as resources for learning (Säljö, 2010). Brown refers to learning ecologies as "a collection of overlapping (virtual) communities of interest, cross-pollinating with each other, constantly evolving, and largely self-organizing" (2002, p. 63). Accordingly, materials come to form integral part of thinking and doing (Vygotsky, 1987), or learning, in our case. Accordingly, the 'things' of learning—that is, 'teachers, learning activities and spaces, knowledge representations such as texts, pedagogy, curriculum content, and so forth' (Fenwick et al., 2012, p. 2)—are seen as 'themselves effects of heterogeneous relations' (p. 2). Learners orient towards materials, which organize the participants' perceptions and activities, while these actions transform the very materials that shaped them in the first place.

3. Methodology

3.1. Objective

From an empirical perspective, it is important to advance understanding of how students navigate and create their learning ecologies, e.g., assemble and self-organize intentions, knowledge, spaces, resources, tools, activities, and/or institutional requirements. The assumption is that such processes are strongly influenced by affordances offered by the state-of-the-art knowledge, practices and technologies, but also by the students' view and actions in relation to these. At methodological level, research aims can connect to a nascent, growing interest in collecting data from multiple sources and making sense of the learners' effort to create their learning ecologies. The main aim of this study is the examination of *students' learning activities at the intersection of various sites of learning* and *how digital technologies are involved in these processes*. This paper addressed these aims by building an argument and illustrating it with empirical data from two distinct research projects, in teacher and software engineering education.

3.2. Participants

One study was conducted in a Software Engineering program at a university of applied sciences, offering bachelor's degrees in the engineering and information

technology; the other a Teacher Education program at a large research university. Direct access to both sample groups was obtained through a call to the students, with the participating students signing up voluntarily. There were sixteen participating students in the software engineering study and fifteen participants in the teacher education study.

3.3. Empirical context and procedure

In the *software engineering* study, we observed and documented an introductory course in web design and development – Web Project. The course contained varied learning and instructional strategies aimed at introducing students to basic programming skills (bi-weekly lectures and labs, a four-week collaborative web development projects). The students had to develop in groups a functional website. The students employed online platforms and tools (e.g., w3schoools, Stack Overflow) as main resources for the programming work, an online repository and collaborative platform used by programmers (Github), Facebook group pages for communication, and Dropbox to store and share their developed object versions, resources and other materials. In the *teacher education* study, the students were in internship schools to observe activities and were placed in pairs (with 'buddies') to develop lessons and didactic materials together. The guidance was organized at school level and all students are visited twice by a pedagogue or subject-didactics teacher from the university. The participating students were equipped with tablets they used to film each other's teaching activities. The films were saved on a secured server and could be accessed online by the students themselves, their buddy(/ies), the university teachers and the school mentor. All participants and supervisors could provide feedback using a text editor, with the feedback comments beings saved as external annotation to the video file.

The data set consisted of: a) in teacher education: interviews with the students and supervisors about the use of the tablet-based video and annotation tools, and b) in software engineering education: video recordings of group meetings, online communication, mock-ups of the website, the final website, and course materials.

3.4 Data analysis

The qualitative content analysis (Braun & Clarke, 2006) was performed focused on identifying: a) how students engaged with their learning tasks of working and communicating across sites by using technologies; b) the way digital technologies were accessed and mobilized; and c) how the students experienced the navigation and work with the support of the digital technologies. The analyses allowed relevant aspects to emerge from the data (an inductive approach). Using generic notions proposed in the theoretical framework, we identified possible patterns of activity and interaction with the digital technologies, and how these are included/involved in the students learning. A number of interesting insights emerged, both of conceptual and practical relevance.

4. Findings

In the software engineering study, the use of online knowledge resources provided by the expert programming community was one aspect revealed by the analyses so far. Some of the sources were suggested by the teacher, such as the w3schools and the online validation tool. The students searched themselves for other resources that could support them in solving programming problems, in finding alternatives for and improving the quality of their websites. The end interviews show that the pursuit of online resources was not incidental or random. The students appeared very aware of the characteristics and practices of the programming domain, where the knowledge resources can be found and how they must act in order to access them. They explained that the online resources are the most updated ones, and that in a dynamic field such as the one of software programming working with up-to-date knowledge is

essential:'…*it's the most updated one. Because programming and stuff changes and the books are getting outdated.*' (End interview Group A). Also, resources that can be accessed fast and efficiently are preferred, because of the pressure to finalize the project in time: '*And speed as well. Indexing. You're right there on your computer. You just need to look it up instead of 'oh, is that book, in the index, and which page and which word. It's instant access to exactly what is necessary to continue the work...*' (End interviews Group C).

In the teacher education study, the tablets, a clear expression of physical materiality, are perceive by the students as ideal tool: *The greatest advantage with using tablet computers is that it's so much easier to bring with you… It's user friendly and it's small and it's…' (Student A).* Here we observe the materiality of the tools being/becoming part of the regular practice, without disturbing the regular routine of the students' activities. Besides this, it is viewed as enhancing practices that would be less sophisticated otherwise: *I've watched them [video clips] afterwards and it gives you a unique possibility to observe yourself. […]It makes you more conscious on how you act, how you use your voice and what you say.' (Student B).* This illuminates how the digital tool contributes to a shaping process the students are involved in for their learning. It is a good illustration for the way these digital-material elements are intertwined with the activities and trigger different processes. Ultimately, the video is supporting a deeper and closer engagement with the teaching techniques, as underlined by the students*: 'It can support me to see and interpret how I act as a teacher…; it can be a class discussion, all through how you act in the class, how you move, and how you use the different learning aids like the internet and PowerPoint and all of those things…' (Student C).* At this level, the digital tools are identified as part of a learning process, wherein theoretical and practical knowledge about teaching is being activated when engaging in reflections on the performed teaching. Here, the digital materiality becomes part of an ecology that includes knowledge, action, reflection. The university teachers, too, appreciated the epistemic potential of the digital materiality to support establishing cognitive trails and to enhance the capability to register and analyze momentary actions: *'they [video clips] make it visible these brief moments […] to that we can watch them over and over again- comment on them, analyze them and use them to develop the understanding… Also, we overcome the limitations of time and space.' (University teacher).* In this case, the tablet and the video become an entity intertwined in the social interaction between students, teachers, but also in the reflection and guidance process leading to better understanding of own actions.

5. Discussion

These preliminary findings indicate that the digital-material tools used (tablet, video, online knowledge platforms, digital repositories) represent a valuable resource for the students' learning process. By allowing and supporting the students to access these extended sources of knowledge, they engage with resources and activities that would not be possible otherwise. The rich pool of coding strategies and guidelines, procedural structures, validation standards and tools in the software engineering study provided the students with choices and inspiration. Embedding the tablet and the video into the activities, ongoing guidance, gives the technology, as embodiment of physical and digital materiality, a shaping role in the teacher students' development of habits, dispositions and ways of orienting towards and using the knowledge, digital and physical resources around them. Further research should examine how digital technologies are intertwined and can serve a more 'connected' learning process and should focus on developing instruments for analyzing the type of learning practices enhanced by these technologies. The pedagogical practice needs, thus, to take into account how digital technologies can be naturally embedded in the formal learning environments and facilitate learning processes determined by the complexity of the knowledge context the students need to operate in, during their studies and after graduation.

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