Human-centered learning design with technology

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To Iria, Nil and Luca

To Arnaud, without whom they would not be our present and future

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Abstract

To improve and innovate education, a novel conception of the role of design in this realm is needed. Human-centered design (HCD), a problem-solving framework underpinned by the user perspective in all stages of the process, provides professional designers with a mindset and a toolbox that includes both process and methods. HCD is multidisciplinary by default and also practice-oriented, context-aware, empathetic and incremental. As such it naturally fits both the design for learning and many of educators' everyday realities. We apply this conception in the context of technology-enhanced learning with the conceptualisation and implementation of a genuine intervention for the design of ICT-mediated learning activities. Following the Activity-Centred Analysis and Design (ACAD) model, the contributions of this dissertation 1) cover the epistemic, social and set design dimensions of a teacher training activity for educators; 2) inform the incorporation of HCD in education; and 3) provide interdisciplinary learnings for research as well as practice. These contributions have been reported in a set of papers which are compiled in this dissertation together with an introductory kappa. The kappa frames and summaries the contributions, and closes with a proposal on how HCD could contribute to empower educators as designers and facilitate the much interdisciplinary collaboration between education, technology and design.

Resum

Facilitar la millora i la innovació docent, requereix d'una nova concepció del rol del disseny aplicat en l'educació. El disseny centrat en les persones (DCU) és una aproximació a la resolució de problemes que inclou la perspectiva dels usuaris en totes les etapes del procés i ofereix als dissenyadors professionals un model mental i els intruments necessaris per aplicar aquest procés i els seus mètodes. El DCU és multidisciplinar per defecte, està orientat a la pràctica, pren consciència del context d'ús, i és empàtic i incremental. Així doncs encaixa de forma natural en el disseny de l'aprenentatge i en la realitat diària del professorat. L'objectiu és aplicar aquesta concepció al disseny de l'aprenentatge mediat per la tecnologia conceptualitzant i implementant una intervenció genuïna per al disseny d'activitats d'aprenentatge que usin les TIC. Seguint el model d'Anàlisi i Disseny Centrat en l'Activitat (ACAD, en anglès), les contribucions d'aquesta dissertació 1) cobreixen les dimensions epistèmica, social i d'eines per al disseny d'una activitat de formació del professorat, 2) informen sobre la incorporació del DCU en educació; i 3) aporten aprenentatges rellevants tant per la recerca com per la pràctica de diferents disciplines. Aquestes contribucions han estat reportades en un conjunt d'articles compilats després de la kappa introductòria. La kappa emmarca i resumeix les contribucions i finalitza amb una proposta sobre com el DCU podria contribuir a apoderar els educadors en tant que dissenyadores i facilitar, d'aquesta manera, la tant necessària col·laboració interdisciplànaria entre educació, tecnologia i disseny.

Contents

LIST OF ARTICLES

1. INTRODUCTION

The notion that education 'lives' in a designed environment hardly becomes apparent in the classroom or lecture room. Although in the early days of the industrial revolution, lecturing (instead of one-on-one teaching) was invented, it now is so much part and parcel of our everyday experience we barely notice education's designed character anymore (Bates, 2015; Garreta-Domingo, Sloep, Hernández-Leo, & Mor, 2017). The advent of technology-enhanced learning changed that, for now conscious decisions have to be made on what technologies to include and how to apply them; that is *design* decisions have to be made. However, there is a tendency to shun innovations through the application of learning technologies, in particular those that may disrupt existing practice (Becta, 2008; Flavin & Quintero, 2018; Kreijns, Vermeulen, Kirschner, Van Buuren, & Van den Acker, 2013). In our view this results from a lack of conscious acknowledgement on the part of teachers that teaching and learning are essentially designed activities. With technology-enhanced learning as our focal point, we aim to show how a conscious design stance may improve education and indeed the use of educational technology as well.

Technology is sometimes seen to form the core of online learning, a complement in blended learning and tangential to face learning. However, this characterization hardly suffices anymore, technology is pervasive and its effects are expansive: it is a constant part of the lives of educators and students; whether it has an "educational" origin or not. Thus questions such as which technology to incorporate, how to integrate it, when to deploy it, how to assess the results of its deployment, and what to do next, all call for conscious decisions. Such decisions are seldom made (Kirkwood & Price, 2014). To remedy this situation *we suggest that the integration of technology in education needs to be 'designed' from the ground up following a human-centered design approach*.

Therefore, our focus is on the activity of designing technology-enhanced learning. This is not a novel idea. It was key, in much work on the the IMS Learning Design specification (e.g. Griffiths and Blat, 2005; Koper, 2005) and still is key in more recent elaborations of the Learning Design field (e.g. Dalziel et al., 2012; Laurillard, 2012). Note, however, that the term 'Learning Design' wrongly suggests that learning can be designed: clearly, at best only the conditions for it can (see also Carvalho & Goodyear, 2014; Goodyear, 2015). It is for this reason that we conceptualize Learning Design as a specialisation of human-centered design, which emphasizes the human agency in adopting design artifacts. Matching the goals of Learning Design, we believe that human-centered design can bring more coherence to the currently rather loosely organised and individually-oriented task of design for technology-enhanced learning. To accomplish this, we contribute to the following research questions:

1. *Which form of epistemic, social and set design could structure the incorporation of HCD in the design for learning?*
2. *Is HCD practice directly transferable to the design practices of educators?*

The kappa essay of this dissertation is structured as follows. We begin with an introduction of our theoretical stance: human-centered design (HCD). In line with HCD principles, we introduce next our users; that is educators as designers. Then, we present our problem space and focus on technology-enhanced learning and its design. The dissertation goals and methodology precede our main contributions. We structure our contributions as follows: 1) insights for the learning design of HCD for educators; 2) learnings regarding HCD for TEL design; and 3) how all these inform several interconnected disciplines. We conclude with a proposal of how TEL and educational technology could be designed.

1.1. Theoretical stance: Human-Centered Design

Human-centered design is the lenses through which we analyze the problem space we address in this dissertation - that is, the design of (technology-enhanced) learning activities. HCD is also the framework we believe can benefit education as well as our focus in this dissertation. Thus, we have worked on how such a framework could be introduced to the target users: educators. It is not directly to HCD that we aim to contribute to, it is on the fields of learning design and educational technology that we focus on. Tangentially, we touch HCD in the sense that we show practitioners and researchers in this field another realm, that of education, to work in.

With Herbert Simon we believe that design is a problem-solving, process-oriented activity and we subscribe to his idea that: “everyone designs who devises courses of action aimed at changing existing situations into preferred ones” (Simon, 1996, p. 111). This quote captures the essence of our point of view: not only designers design but everyone does at some point of time. Nevertheless, we also consider design to be a specialist undertaking. As such, its results profit from the just mentioned specific mindset, set of methods and defined process.

Human-centered design (HCD) provides this specific mindset, toolbox of methods and a process. Some of these are clearly defined by the six key *principles* that guide the implementation of HCD from the ISO 9241-210 'Ergonomics of human-centred system interaction' (ISO, 2009):

1. the design should be based upon an explicit understanding of users, tasks, and environments;
2. users should be involved throughout the design;
3. the design should be driven by user-centered evaluation;
4. the process should be iterative;
5. the design should address the whole user experience; and
6. the design team should be multidisciplinary in terms of skills and perspectives.

We strongly believe that these principles should also guide the conceptualization, implementation, integration and refinement of technology-enhanced learning and educational technology. We use the ISO as, from our experience, such formal and external references make HCD more reliable, more solid to outsiders in the field. This relates also to our choice of references in this essay: it is the practice of HCD that we want to "export" to the practice of design for learning. Like Carvalho and Goodyear (2017, see also Goodyear, 2015), we believe that education is a neglected realm in HCD and its ramifications; as a result, education has not yet benefited from HCD. We focus on the latter in this dissertation. Through the ISO principles, we start introducing our rationale.

As per the first principle, HCD is a design philosophy that incorporates the end user's' perspective at each step of the product or service development. This way both the design process and its results become humanized in a two-way process of information exchange (Norman, 2013; Cooper, 2004). This is linked with the concept of iteration (principle 4) and fits with current HCD developments such as the idea of "sense & respond" (Gothelf & Seiden, 2017). Crucially, humans are a prominent part of the equation and so we also embrace a bidirectional relationship between users and designers.

In education, there are two main groups of users: educators and students. Note, however, that our focus lies with the meta-level of the design of learning. That is, we do not focus on how learning design affects the learners but rather on the question of *how to support educators in their design activities*. In our view, the realm of the design for learning - that is, the design of technology-enhanced learning activities - ought to be governed by educators. Thus, in this layered environment of education, educators are our key target users, their users in turn are their students. Educators - forming education's micro-level - also become the "bridge" with other stakeholders - such as learning technologists or instructional designers - who contribute to the creation of technology-enhanced learning activities and educational technologies *per se*.

In a HCD process, users are continuously involved in service or product development (principle 2). The ways in which this is done vary depending on the development stage and of course the resources available, both in time and budget. It is key to define evaluative "checkpoints" in order to integrate the users' feedback into the development of the designs (principle 3). This evaluation also needs to be designed: how will the integration of that specific ICT tool be assessed? Which inputs will the educator use to decide what to do next?

The fifth principle demands that the effects and, thus, the evaluation of technology-enhanced learning be analyzed at the system level. It is not just the tool per se that counts but also how it supports the learning activity, how it is perceived and grasped by the students, how the educator can follow what is going on, etc. The field of Teachers Inquiry into Student Learning (TISL) (Wasson & Hansen, 2016) suggests the idea that the usage of student data is a skill that teachers must develop in order to teach in the information and technology-rich classroom (data literacy).

However, this suggestion takes us back to our previous claim: individual educators themselves cannot be expected to master and orchestrate the increasingly complex and diverse array of tools, resources, activities, data and people that make up learning ecosystems. This is why, unlike fields such as TISL or Teachers as Designers (Kali, McKenney, & Sagy, 2015), we bring in principle 6: educators should be surrounded by multidisciplinary teams in terms of skills and perspectives.

To sum up our design stance, we adopt human-centered design as our preferred lens because:

1. It is a mindset, one that entails a specific and guided approach to problem-solving.
2. It acknowledges the role of humans both as designers and as users of design processes, services and artifacts.
3. It is system-aware, it does not take technology or the users out of their context. It concerns itself with the many forces that interact and collide.
4. It is process-oriented and provides a set of methods to address design as a continuous activity based on learning from and improvement of the designed artifacts.

These characteristics, we propose, should provide the guiding principles for the processes of conceptualization, implementation, evaluation and improvement of technology-enhanced learning. Although the design stance we advocate does not restrict its use to technology-enhanced learning contexts in education, it best shows its strength there.

With the growing intricacy and pervasiveness of technology, human-centred design has evolved and branched into different fields; although with different approaches and names they all share a focus on the end user of a product or service. Thus, whether one calls it "user experience" (UX), "design thinking", "service design" or "lean UX", all are still following the same human-centred design principles.

Whereas in academia, human-computer interaction is the common term for the same concept, user experience (UX) (Kuniavsky, 2003) is the most widespread name in the industry and less formal training settings. Design thinking (Buchanan, 1992, to cite just one) is also well-known and promotes an empathic, empirical and iterative approach, again very similar to human-centred design.

Service design (Stickdorn & Schneider, 2012) openly acknowledged the idea that user experience is holistic and encompasses all moments and levels of a user interacting with a service and not just with the product itself. Thus, the design needs to encompass people, infrastructure, communication and material components of a service. Carvalho and Goodyear (2017) advocate the application of service design ideas and methods in the realm of education as "design for learning is hybrid, involving mixtures of service, product and space design. This hybridity is accompanied by a need for a more complex knowledge-base for design than is sometimes found in discussions of knowledge for university teaching" (Goodyear, 2015).

The design of technology-enhanced learning should not only learn from service design but also incorporate more "agile" and novel approaches which - again based on the same HCD principles - call for faster cycles of design to constantly learn from users and, thus, reduce uncertainty (Gothelf & Seiden, 2017). As is characteristic of the social realm, educators cannot know beforehand the impact and effects that a given learning activity will have. Approaches such as "lean UX" and "agile development" focus on how to learn about this impact as early as possible to make the necessary adjustments to the designed service or product.

In Lean UX (Gothelf & Seiden, 2016) as in the Lean Startup movement (Ries, 2011), the design cycles consist of three phases: learn, build and measure. The main difference with HCD - besides the focus on short cycles - is that the process starts with a solution (normally a Minimum Viable Product) as opposed to an initial period of investigating the target users. The goal of the minimum viable product is to put the product in the hands of users as soon as possible to gather feedback to input in the next product iterations.

Thus, as Gothelf & Seiden state (2017), any company needs to establish a continuous conversation with its users in order to learn from them and include these learnings in the product development. This approach also involves a shift in focus: instead of working to get "outputs", teams should aim to get "outcomes". This is best done through cross-functional and autonomous teams, whose main goal is to learn about the interaction between the users and the designed product or service. These newer HCD approaches have also incorporated the scientific method to guide the validation of assumptions and hypotheses, all aimed at reducing uncertainty.

There have been attempts to strengthen collaboration and combine perspectives of designers, educators and educational technologists, but research on how to organize this is still limited. Researchers have tested the integration of educators in the design processes: research for practice (Shrader, Williams, Lachance-Whitcomb, Finn, & Gomez, 2001); design-based implementation research (Penuel, Fishman, Haugan Cheng, & Sabelli, 2011); teachers as collaborative designers (Cviko, McKenney, Voogt, 2014; Hernández-Leo, Moreno, Chacón, & Blat, 2014; Voogt et al. 2015; Svihla, Reeve, Sagy, & Kali, 2015); teachers as participatory designers (Cober, Tan, Slotta, So, Könings, 2015); or through partnerships (Matuk, Linn, & Eylon, 2015). These initiatives go a long way, however they fail to properly empower educators.

1.2. Users: Educators as designers

Following human-centered design principles and nomenclature, educators are our target users. Since educators liaise with both students and their educational institution they bear the ultimate, practical responsibility for the design, enactment and development of TEL activities. Consequently, their role is pivotal in any effort to incorporate the HCD mindset, process and methods in education.

But how do teachers design and what, if any, underlying constructs support their design process? We will not cover these questions extensively, as our aim is merely to provide an overview of the considerations that guide educators' design activities. Bennett et al. (2015) found the following key influences on design decisions for Higher Education teachers: 1) teachers' beliefs and experiences, 2) teachers' perceptions of student characteristics, and 3) contextual factors. Similarly, Boschman, McKenney, and Voogt (2014) found that the considerations Kindergarten teachers entertained during design were influenced mostly by practical concerns, although their pedagogical orientation, beliefs about how children learn, and convictions of how learning should be supported by teachers also played a role.

If we look into the TEL field specifically, Ertmer (1999) distinguished between two types of barriers that impact teachers' uses of technology in the classroom: 1) first-order barriers defined as those that are *external* to the teacher and include resources (both hardware and software), training, and support; and 2) second-order barriers comprise those that are *internal* to the teacher and include teachers' confidence, beliefs about how students learn, as well as the perceived value of technology to the teaching/learning process. These two types of barriers return in more recent research, such as by Matuk et al. (2015), who reported how teachers' decisions in customizing technology-enhanced learning materials are the result of interactions between knowledge of their students and the subject matter, beliefs about teaching and learning, and orientations toward technology and their roles as designers. So it is safe to conclude that beliefs, perceptions and context determine teachers' design decisions.

A) Teachers' beliefs and experiences

Second-order barriers, internal to the teacher, have proved to pose the greater challenge to achieving technology integration (see also Kreijns et al., 2013). All these barriers operate very much at an unconscious level and are deeply rooted in the experiences and beliefs of educators. Some authors argue that teachers' beliefs about education are difficult if not impossible to change (Pajares, 1992). With Wright (1997) and Beijaard and De Vries (1997) it is our position that teachers' pedagogical beliefs may be changed but that this depends on the content and nature of the influences a teacher undergoes.

Teaching requires a complex set of knowledges, as illustrated by the Technological Pedagogical and Content Knowledge framework. This conceptual framework (Magnusson, Krajcik, & Borko, 1999) for educational technology builds on Shulman's formulation of ‘‘pedagogical content knowledge’’ (Shulman, 1986) and incorporates the role of technology in education.

The relationship between content (the actual subject matter that is to be learned and taught), pedagogy (the process and practice or methods of teaching and learning), and technology (both commonplace, like chalkboards, and advanced, such as digital computers) is complex and nuanced (Mishra & Koehler, 2006). The analysis of the interplay needs to consider these components as a whole, in pairs, but also in isolation. Moreover, knowledge and beliefs are closely interwoven, "the potent affective, evaluative, and episodic nature of beliefs makes them a filter through which new phenomena are interpreted"; that is, "beliefs influence knowledge acquisition and interpretation, task definition and selection, interpretation of course content, and comprehension monitoring" (Pajares, 1992). Beliefs are highly individual, deeply personal, persistent and are formed by past experiences (Kreijns et al, 2013). Educators can discuss sophisticated ideas of instruction in the abstract, for example on how to incorporate educational technology. And yet, specific design situations invariably activate experiential knowledge, which more often than not leads to traditional forms of instruction.

Pedagogical knowledge requires educators to understand how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions towards learning. As such, it demands an understanding of cognitive, social, and developmental theories of learning and how they apply to students in their classroom (Mishra & Koehler, 2006). This is the type of knowledge that one expects educators to master. Yet, many educators lack this "deep pedagogical knowledge". In the terms of Kali et al. (2011), the pedagogical knowledge of educators often takes the form of 'folk' beliefs. While it is true that educators think in terms of learning outcomes and the change they want to promote, they seldom ground their praxis in theories (Bennett et al., 2015).

This does not mean that educators are not concerned with pedagogy but that, rather than having a coherent and consistent theory of teaching and learning, teachers apply a loose collection of practice-oriented strategies, each one locally coherent, although not necessarily systematically validated. Kali et al. (2011) call this notion "pedagogical knowledge in pieces". In fact, much relevant teacher design expertise comes intuitively, is acquired on a daily basis and congruent with the teacher's beliefs and convictions (Beijaard & De Vries, 1997).

This "pedagogical knowledge in pieces" is adequate for the praxis of teaching. However, it hampers the systematization of learning designs and the conversation with other disciplines. It actually clashes with commonly held ideas of what educators know. For an outsider, educators are experts in pedagogy. It is assumed that they ground their practice in validated theories of learning. As we have discussed, this turns out not to be the case. We believe that this gap between how educators operate in the field and what others, including other disciplines, expect from them is at the core of many tensions in the implementation of educational technology.

In sum, teachers' beliefs operate very much at an unconscious level and are deeply rooted; thus, some authors argue that teachers' beliefs about education are difficult if not impossible to change (Pajares, 1992). With Wright (1997) and Beijaard and De Vries (1997) it is our position that teachers' pedagogical beliefs may be changed but that this depends on the content and nature of the influences a teacher undergoes. Indeed, there is a bi-directional relationship between pedagogical beliefs and technology use (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). As a result, teachers' experiences with technology can become enablers for supporting pedagogical belief change. It is this 'experience' that we aim to change through exposing educators to the HCD mindset, methods and process.

B) Teachers' perceptions of student characteristics

Stark (2000) reported how educators' design decisions were strongly influenced by the perceived characteristics of their students. These beliefs not only affect the conceptualization of the learning activities but are beneficial also during their implementation and evaluation. A student-focused approach allows a teacher to be responsive to student needs and interests during the enactment of the activities (Postareff, Katajavuori, Lindblom-Ylänne, & Trigwell, 2008). At a broader level, Bennett et al. (2015) reported that several authors have concluded that student-focused approaches to teaching encourage deep approaches to learning, that result in high quality learning outcomes.

Research shows that teachers' student-centered beliefs tend to result in more authentic uses of technology while traditional beliefs tend to have a negative impact on the integrated use of computers (Hermans, Tondeur, van Braak, & Valcke, 2008). As Ertmer et al. (2012) confirm, results suggest close alignment; that is, student-centered beliefs undergird student-centered practices (authenticity, student choice, collaboration). Despite such beliefs there are also constraints that prevent student-centered practices to blossom to the full. Teachers with student-centered beliefs do not necessarily translate those beliefs into learning activities that use technology as a cognitive partner or indeed in activities that use technology at all. In fact, educational practitioners often see technology as a burden, an imposition (Kreijns et al, 2013; OECD, 2015). Matuk et al. (2015) provide some light on the reasons of this phenomena: "Research also indicates that whereas attendance to students' ideas can result in customizations that greatly benefit learning, *issues of practicality primarily drive teachers' intuitive customizations*" (italics ours).

C) Contextual factors

Many researchers such as Brown & Edelson (2003) emphasize the situated and practice-oriented design work that educators accomplish. This pragmatic approach to design means that educators privilege practicality and feasibility (McKenney, Kali, Markauskaite, & Voogt, 2015) and leverage practice-based experiences to make decisions (Roschelle & Penuel, 2006).

Thus, teacher designs are practice-driven and practice-oriented (Doyle & Ponder, 1977; Ertmer, 1999; Janssen, Westbroek, Doyle, & Driel, 2013; Boschman et al. 2014; Matuk et al. 2015)**.** Practicality and feasibility are the key drivers of educators when designing: teachers must ensure that the enactment with the students fulfills the learning outcomes and, for that, possible barriers have to be reduced to a minimum.

As part of the practice-driven component and relevant to take into account as a separate factor, many authors have stated the relevance of context (Bennett et al. (2015) and McKenney et al. (2015), for example). Context needs to be understood not as the immediate physical space of the classroom but in a broader sense, as encompassing all factors and constraints impinging on the educator. These include the customary meso level of the school and the macro level of national educational policies and whatever bodies oversee and monitor the operation of schools.

D) Towards reflection-in-action

Designing is a complex and intricate task. It demands of the designer to take into account and integrate many different and diverse elements. It also requires her to consider the problem and the solution from many different perspectives. This description of design deeply resonates with an educator's work. Teachers are designers of learning, they must perceive, interpret and enact existing resources, evaluate the constraints of the classroom setting, balance tradeoffs and devise strategies – all in the pursuit of their instructional goals (Brown & Edelson, 2003). So, there can be little doubt that the praxis of teachers involves design:

- As in design, teaching is a highly complex activity that draws on many kinds of knowledge (Mishra & Koehler, 2006).

- As with the problem spaces in design, teaching occurs in ill-structured, dynamic environments and, therefore, teaching also deals with what are known in design as wicked problems (Opfer & Pedder, 2011; Rittel & Weber ,1973; Sloep, 2013).
- As in design, teaching is iterative: it seldom happens just once; there is a continuous enactment and tweaking of activities and resources (Bates, 2015; Pardo, Ellis, & Calvo, 2015).

However, as we saw, teachers design in an intuitive fashion, with a focus on direct educational practice, making use of an eclectic collection of pedagogical insights that are informed by their own practice and perhaps those of others they know about than by theoretical insights. Various authors discussed in the above have argued this position. Many also have wondered how the design abilities of teachers could be improved upon (Goodyear, 2015). This is also our goal. Unlike many others, who seek recourse to better ‘persuasive communication’ or ‘skills-based training’ (e.g. Kreijns et al, 2013), we put our faith in the introduction of HCD. This is a novel perspective, one we believe has a better chance of delivering on its promises.

Schön (1983) defined the kind of intuited expertise as “designerly ways of knowing”, which are learned through direct and indirect engagement in authentic design practices, rather than an explicit, formally-represented body of knowledge and skills. According to Schön, professionalism is gained by *reflection-in-action*, which enables the practitioner to think deeply about situations while they are happening, interpret and frame them in particular ways and adapt his/her actions accordingly, as opposed to *reflection-on-action*, which is done after the fact, much as an afterthought. In design terms and in agreement with Goodyear (2015), “a teacher who doesn’t have a sense of design as a process, and who doesn’t have the conceptual tools and skills to work through a design problem in a creative but structured way, will be likely to jump straight to a solution.” (p. 31).

Similarly, Kali et al. (2011) explored how novices carry out design activities. They report how they exhibit a lack of Schön’s reflection-in-action, which derives from experience. Using HCD terms, in their ‘rush to implementation” (Goodyear 2015 p.31) novices skip two key phases of the design process: the exploration phase and the analysis/reflection phase (Hoogveld, Paas, Jochems, & Merrienboer, 2002). They ignore the “fuzzy front end” (Sanders & Stappers, 2008) of exploration. But this is a critical phase, one that determines what is to be designed and sometimes what should not be designed; in it designers take into account considerations of many different natures. As such it is a divergent phase that once all elements considered converges towards the most adequate solution. A reflection phase - after implementation - needs to follow as it drives continuous improvement, like learning by doing. Yet, novices also often skip this phase; thus failing to take the opportunity to use the enactment of the learning activities as a source for learning and enhancing their practices. Given this, we can see how, empowered with a (guided and formal) design process, educators - both novices and experts - could move into reflection-in-action.

We also saw earlier how some educators take into account the students' characteristics, an activity which is also key in HCD. Nevertheless, these judgements are currently reliant on recollections and impressions built up over time and through contact with students, not on systematic data collection. This raises the question of the quality of the information that educators have about their students (Bennett, et al., 2015). Here again we make our call for the incorporation of human-centered design; which as a mindset promotes student-centeredness and also provides the methods and process to put it into practice.

In addition, HCD is - like the practice of educators - context-aware. Thus, it is not only that HCD and designing for learning are similar activities, it is also that the way HCD designers accomplish these activities is very much aligned with how educators already behave. They just lack the adequate knowledge and tools to both leverage the learnings from the design field and also to communicate with professionals from other disciplines; such as educational technology.

1.3. Focus: Technology-Enhanced Learning (TEL)

Many educators pride themselves on being pedagogically (as opposed to technologically) driven in their teaching and learning designs (Anderson & Dron, 2011). Without delving into the many possible reasons, we do acknowledge that there still are tensions when it comes to incorporating technology in education. Terry Anderson (2009) uses the metaphor of a *dance* to explain how technology and pedagogy intertwine: technology sets the beat and creates the music, while pedagogy defines the moves. Pursuing this metaphor, we can view Jonassen and Reeves' categories (Jonassen & Reeves, 1996) of how students interact with technologies as three different types of dances, scripted by educators. Their categorial system differentiates between *learning about technology* (technology as a subject), *learning from technology* (technology as a delivery tool) and *learning with technology* (technology as a cognitive partner). When we described the use of technology in education as either incremental or disruptive, it is only the third option – technology as a cognitive partner - that holds promises for innovation; whether incremental or disruptive.

In spite of decades of research and implementation by educational researchers (Jonassen & Reeves 1996; Jonassen, Carr, & Yueh, 1998; Ertmer & Ottenbreit-Leftwich, 2012a; Ertmer, Sadik, Sendurur, & Sendurur, 2012b) and educational technologists (Brown, Dehoney, & Millichap, 2015; Merriman, Coppeto, Santanach-Delisau, Shaw, & Aracil, 2016; Dron & Anderson, 2016) the mainstream mode of adoption of educational technology still sees *technology as a delivery tool*. The alternative view, espoused by modern educational researchers and technologists, promotes *technology as a cognitive partner*, as a 'mindtool' that helps students construct their learning and develop higher order skills, such as reflection. This is the kind of technology usage we promote, thus hoping to facilitate authentic student learning (see also Sloep, 2013).

With this aim in mind, several institutions have already worked on the development of post-Learning Management Systems (LMS) solutions. This is the case of the OUNL and Athabasca University, for example. The former, under the name of *yOUlearn* (formerly *OpenU*), has created a learning system with four distinct environments: the Personal Learning Network, the Course Learning Network; the Professional Development Network and the topic/research networks (Hermans, Kalz, & Koper, 2014). Similarly, to support the need for social learning, Athabasca University has developed *Athabasca Landing*, an Elgg-based beyond-the-LMS social system (Rahman & Dron, 2012). These solutions are part of what Anderson and Dron (Anderson & Dron, 2011; Dron & Anderson, 2016) define as the "fourth or holistic generation" of educational technology; one that will be deeply integrated within learners' whole lives and those of others.

These new environments respond to the increasing unease with existing LMSs (Kop & Fournier, 2013) and the need for more social-oriented, not course-limited environments. About ten years ago, the limitations and constraints of mainstream LMSs gave birth to the Personal Learning Environments (PLEs) concept (Wilson, Johnson, & Sharples, 2007). Whereas the LMS is built around the course concept and intended for formal instruction in particular, the idea behind the Personal Learning Environment is that it is governed solely by the learner. Essentially, PLEs aim to facilitate students' use of technology as a cognitive partner (Rajagopal, Van Bruggen, & Sloep, 2017).

The current state of the TEL art is that there are a myriad of technology tools and devices that currently support technology-enhanced learning, which can be integrated through a "Lego-approach", already foreseen in the PLE literature and now in the Next Generation of Digital Learning Environments (NGDLE) reports (Table 1). This next generation is closer to a learning ecosystem: a learning environment consisting of learning tools and components that adhere to common standards and enable different and diverse pedagogies.

Table 1. *Characteristics of the next generation of digital learning environments*

The NDGLE: A component infrastructure to leverage technology for teaching and learning	
The Next Generation Digital Learning Environment: A Report on Research - EDUCAUSE 2015 (Brown et al. 2015)	Next-generation environments must address five dimensions: interoperability and integration; personalization; analytics, advising, and learning assessment; collaboration and accessibility and universal design.
The Next Generation Learning Architecture - (Merriman et al. 2016)	The next generation of digital learning environments consists of a marketplace of Enterprise Infrastructure Services and a marketplace of educational applications, of various types or classes, that consume Enterprise Infrastructure Services. A new class of applications, the Learning Method eXperience (LMX) provides the context and overall user experience required for a particular educational methodology or pedagogical model.
Educational Provisioning System (EPS) - (Hermans et al. 2015)	Rather than implementing provisioning rules directly in an online learning system, the EPS allows for managing provisioning rules independent of the learning application(s) in use. This EPS allows for both managing and processing provisioning rules in order to meet the demands of new online educational formats.

This flexibility, disaggregation, modularity, Lego-structure of the upcoming educational-technology environments is extremely challenging from the designers' and users' perspectives since it places the focus on their activities. The underlying characteristic of NGDLE is that learners and educators will be able to shape and customize their learning environments to support their needs and objectives. This is of course very much in line with the ideal of the use of technology as a cognitive partner. Yet, still most educational technology is developed without the inputs from educators or educational sciences

(Könings, Brand-Gruwel, & van Merriënboer, 2007; Könings, Seidel, & van Merriënboer, 2014).

On the other hand, the NGDLEs bring the opportunity to explore new approaches and develop new tools due to its component-based architecture grounded in standards and best practices. The success of these learning ecosystems is highly dependant on the processes and activities that actually involve learning science knowledge as well as educators (and at a later stage, students) in the conceptualization and refinement of the educational technologies' features. Without this involvement, *learning* will still not be part of the environment and it will be yet another technology limited to the status of delivery tool at best.

As a result, technology-enhanced learning is at a paradoxical stage. On the one hand, practitioners of all related disciplines - educational researchers, educators, learning technologists - agree on the essentials: 1) learning with technology has yet to mature; 2) technology in education should become a cognitive partner, a mindtool. On the other hand, the means to make this happen have not yet been established.

Our proposal is that HCD provides these means to purposely implement TEL as a cognitive partner and impact the three levels of learning and teaching - micro, meso and macro. HCD will facilitate the "conversations" between these levels and related stakeholders by providing, first of all, a shared mindset: all work for the end users' (students') needs; and secondly, by establishing a process and the tools that allow one to integrate these needs and context into TEL designs and also the educational technology involved.

In fact, following the NGDLE metaphor of Lego pieces, our approach also puts into play the human pieces. Only with an interplay of disciplines will education include technology as a cognitive partner, will educational technology be designed for its users and will learning environments be designed for learning. And we will do so by offloading a precious yet battered resource: educators. Then, we will see the same evolution as professional designers will soon have to embrace (Manzini, 2015; Sanders, 2006): both educators and designers will be *enablers*, facilitators and process managers for others to learn and design, respectively.

2. DISSERTATION GOALS AND CONTRIBUTIONS

2. 1 Dissertation goals: HCD for the design of technology-enhanced learning activities

We introduced technology-enhanced learning as our focal point and showed at what paradoxical stage it is. First and foremost, both educational and educational technology researchers and practitioners strive for the same aim: technology as a cognitive partner. However, existing silos and tensions are impeding this goal to become a reality. Our position is that human-centered design can act as a glue and a facilitator; by providing a common and ‘neutral’ methodology.

HCD as well as its ramifications (i.e. UX, service design, lean UX) is both a philosophy and a framework. As such, it brings to product / service development a specific mindset (how to approach and solve problems), a toolbox of methods (to facilitate putting this mindset into practice), and a process (to guide the incorporation of human / users touchpoints in the development). As a consequence, HCD also provides a common language and a clear end goal: to focus on the users. This emphasis on the end users is essential to build alignment among disciplines and functions. A shared language also helps ensure ensure that all participants are “on the same page”.

All these characteristics make of HCD a powerful framework which can not only impact the micro-level but also the meso and macro ones. Our dissertation focuses on the first level as educators are owners of the design of learning activities. Our concluding remarks expose how we envision the change reaching to the meso and macro levels.

It is, then, our believe that human-centered design can empower educators and bring more coherence to the currently rather loosely organised and individually-oriented task of design for learning with ICT tools. We address this by answering the following research question: *Which form of epistemic, social and set design could structure the incorporation of HCD in the design for learning?*

Such incorporation should provide teachers with the right skills, tools and process so that they are better empowered to integrate technology as a cognitive partner for their students. But, *Is HCD practice directly transferable to the design practices of educators?* We answer this research question by breaking it down into the following intertwined aspects:

1. The human-centered design *mindset* in the design of technology-enhanced learning,
2. The human-centered design *process* for the design of ICT-based activities and educational technology, and
3. The human-centered design set of *methods* to the design for learning.

Moreover, while we have exposed some ‘educators as designers’ patterns emerging from existing research, some authors (Agostinho, Bennett, Lockyer, & Harper, 2011; McKenney et al., 2015) also point out how more empirical research is needed to better understand teachers’ design practices so that closer alignment between teachers’ needs and their design initiatives can be achieved. Our research contributes to this need. With Goodyear (2015), we are not saying that “design is a panacea”, however, we do believe that “established design professions have some methods for dealing with very complex issues, resolving conflicting requirements, reframing problems, and working with ‘end users’ (customers and clients; students) that are useful in educational practice”. We aim to contribute to the body of knowledge of how educators design through the implementation of a real-world intervention; to bring closer the design for learning and HCD and its ramifications thus reducing the current gap between them (Carvalho & Goodyear, 2017).

2.2. Research methodology

We have introduced why we think that human-centered design can bring more coherence to the currently rather loosely organised and individually-oriented task of design for technology-enhanced learning. We set out to investigate this affirmation through the following research questions:

1. *Which form of epistemic, social and set design could structure the incorporation of HCD in the design for learning?*
2. *Is HCD practice directly transferable to the design practices of educators?*

Given our HCD lenses, we adopt a Design Based Research methodology (Amiel & Reeves, 2008) as it also advocates for repetitive iterations and refinements of the solutions as a systematic process. Thus, this dissertation is framed within an interpretative research paradigm (Orlikowski & Baroudi, 1991).

In order to carry out this interpretation and, thus, answer our research questions, we designed a genuine intervention for teacher training which allowed us to observe educators carrying out a HCD design project. Only through such a particular authentic training context we can answer our second research question.

Considering the authenticity of our intervention, our exploratory research relies mainly on qualitative evidence (Asensio-Pérez et al, 2017); even if, to provide more context (in particular trends), our research design followed a concurrent, embedded, mixed-methods strategy (Creswell, 2014).

Aligned with our first research question, the design and analysis of the intervention was done following the Activity-Centred Analysis and Design (ACAD) framework (Goodyear & Carvalho, 2014; Carvalho & Goodyear, 2017); which places the learning activity at the center of the design process and differentiates between three different dimensions: epistemic, set and social (Table 2).

Like HCD, the ACAD framework acknowledges the interplay of the different components in a system. It is our belief that we need this holistic perspective to build the next generation of digital learning environments and pedagogies and, as a consequence, the next generation of educators and learners (Sloep, 2016).

Table 2. *Learning design dimensions according to Goodyear and Carvalho (2014) and how they were designed in our intervention*

Dimensions	**Short description**	**Our intervention**
Task structure and **epistemic design**	Epistemic design refers to the knowledge-oriented structure of a network; the activity is goal-oriented and facilitates learning and knowledge creation.	A Massive Open Online Course (MOOC) that walks educators through the design process of an ICT-based learning activity of their own making.
Structures of place and **set design**	The activity is also shaped by the physical / digital setting in which it unfolds. Thus, the relations between place, tools and activity are key to both analysis and design.	A combination of online tools chosen to provide the necessary learning and design support to the design efforts of the MOOC participants.

Organizational forms and **social design**	What people do is often influenced by the actions of other people around them, including the instructions, advice, encouragement and warnings they give. At a broader level, social norms, rules and habits tend to have an effect, even if other people are not physically around.	A set of facilitators to guide participant educators through their design processes; together with the comments and feedback from their peers. And of course the set of norms, rules, etc. that each participant brings along, which are outside of intervention control.

The context of our intervention was a Massive Open Online Course (MOOC) on a topic that - as we have seen - many teachers struggle with: the inclusion of ICT in education (OECD, 2015). As mentioned, it was intended to offer a genuine professional development opportunity for educators of all educational levels (Garreta-Domingo, Sloep, & Hernández-Leo, 2018; Stoyanov, Sloep, de Bie, & Hermans, 2014).

The HANDSON MOOC - implemented under a Lifelong Learning Programme project (http://www.handsonict.eu/) - was open and free. Under the title 'Learning Design Studio for ICT-based learning activities' and based on HCD methods and process, the course guides participants through a design inquiry cycle (Mor & Mogilevsky, 2013); during which they identify an educational challenge, investigate the context in which it is situated and the relevant pedagogical approaches, review examples of past innovations for inspiration, conceptualise a solution, prototype and evaluate it, and reflect on the process and its outcomes.

The *set design* of the MOOC included Moodle, for the first edition, and Canvas, for the second one, as the course platform; Moodle / Canvas contained the syllabus, the design tasks as well as the discussion forums. The Integrated Learning Design Environment (ILDE) was the design platform on both occasions; this web platform allows communities of educational designers to co-create and share learning designs both from scratch or by using templates provided (Hernández-Leo, Asensio-Pérez, Derntl, Pozzi, Chacón-Pérez, Prieto, & Persico, 2018).

The MOOC's *social design* comprised interaction with facilitators and peers in the forums and through weekly synchronous sessions. The first iteration of the MOOC featured three facilitators experts in Learning Design and HCD. The second iteration was offered in seven languages in parallel, thus there were 15 facilitators who addressed the students in their native language. These facilitators were all volunteers; they had no formal HCD expertise, but were trained to act as process managers for the participants. English was used for instructions and general communications only. To learn more about this multilingual experience see Colas, Sloep and Garreta-Domingo (2016).

The *epistemic design* was grounded in the idea of *learning design studio* (for details, consult Mor & Mogilevsky, 2013; Reimer & Douglas, 2003; Winograd, 1990). In this online studio, participants designed a TEL activity that by the end of the course was intended to be ready for enactment in their respective teaching settings. The epistemic design concerns the tasks learners (in our case, educators as lifelong learners) carry out in order to acquire new knowledge. Following our focus on human-centered design to empower educators as designers, our epistemic design mimics a HCD process from considering the user requirements, to conceptualising the solution and, then, testing it on each iteration (Figure 1).

Figure 1. *The HANDSON MOOC's (2nd edition) course activities.*

Design Studio for ICT-based Learning Activities - HANDSON MOOC (2)

Week 1: Initiate **Learning goals:** Get acquainted with LDS and define an initial version of the educational challenge.	A1: Introduction to the Design Studio for ICT-based Learning Activities! A2: Set up your Design Studio Journal. It is a tool for you! A3: ILDE Account and Dream Bazaar A4: Peer-mentoring - your dream!
Week 2: Investigate **Learning goal:** Get acquainted and apply HCD methods for user needs analysis. Review educational challenge based on peer feedback.	A5: Get familiar with the persona concept A6: Create your own persona A7: Analyzing context, factors and concerns A8: The objectives of your ICT-based learning activity A9: Revisit your dream and update it A10: Peer-mentoring - Your personas!
Week 3: Inspire & Ideate **Learning goal:** Continue user needs analysis and shaping the learning activity. Start thinking on monitoring the experience.	A11: Define the heuristics for your design project A12: Search for existing ICT-based learning activities A13: Learn about user scenarios A14: Ideate through writing a user scenario A15: Peer-mentoring - The objectives
Week 4: Prototype **Learning goal:** Translate the results of previous tasks into a prototype and assess it with a user or peer.	A16: Prototype your artifact A17: Revisit and update your evaluation heuristics A18: Test your prototype *Advanced authoring and implementation* A19: Consolidate your prototype A20: Peer-mentoring - Consolidate your prototype
Week 5: Evaluate & Reflect **Learning goal:** Receive peer feedback on the design activity. Reflect on the course.	A21: Publish your learning activity A22: Peer-mentoring - Your learning activity A23: Your design studio report A24: Reflect and share your thoughts!

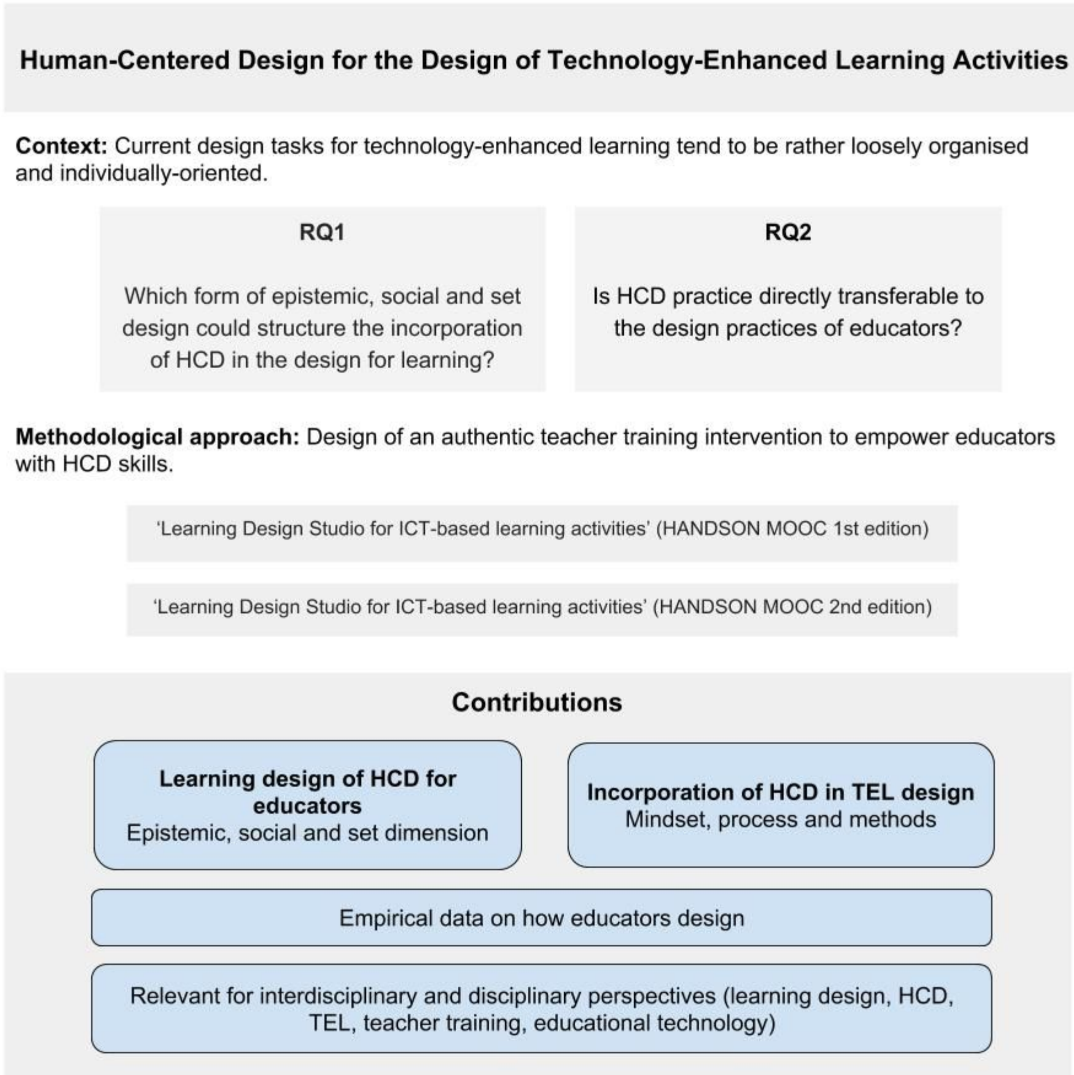
Following HCD and DBR principles, we applied a continuous and iterative approach to the design of the MOOC. Three versions of the course were tested and assessed; the first one being a pilot reviewed by experts. Table 3 summarises the design differences between the two (real) editions of the MOOC.

Table 3. *Summary of design changes between the two editions of the HANDSON MOOC*

	First Edition	Second Edition
Epistemic design	20 tasks set to participants (in English) Two tasks related to evaluation protocols	23 tasks set to participants (in English) Peer-mentoring tasks part of the course; one task for evaluation
Set design	Course VLE: Moodle	Course VLE: Canvas
Social design	English only peer-feedback, public and promoted by facilitators. On Moodle and ILDE	One peer-review task per week with rubrics, private to peers involved in task. Feedback was given in one of the seven languages supported. On Canvas

More details about the methodology, data collection instruments and analysis are reported in the papers compiled in the dissertation.

Figure 2 visually summarises our research context, the research questions, methodological approach and the contributions of this dissertation; which are detailed in the next section.



2.3. Main dissertation contributions

The contributions of the dissertation have been published in journal and conference articles. Each of the articles is focused on a design dimension as defined in the ACAD model and follow the kappa essay.

Both in HCD and the ACAD framework authors emphasize the importance to carefully distinguish between what can be designed and what cannot: “We *may* be able to design the thing that is experienced, but we cannot design the experience itself” (italics theirs) (Goodyear & Carvalho, 2014 p. 57). The context, the tasks and the tools can be designed;

however at learn time learners - or, at the experience time, users - are likely to reconfigure what has been proposed in new ways (see also Goodyear, 2015). We present next the key learnings from our two HANDSON MOOC editions and how they were experienced by its participants.

A) Contributions to the learning design of HCD for educators

The main features characterizing the HANDSON MOOC are:

1. Focus on the Learning Design Studio approach to help educators design ICT-mediated learning activities.
2. Emphasis on hands-on design tasks.
3. Open to educators from around the world, from all sectors and subjects.
4. Involve facilitators with expertise in Online Learning, Creativity and Learning Design.
5. Offer an opportunity to observe and practice methods for peer review and mentoring.
6. Creation of practical artefacts that can be used by the participants in their classrooms.

We present next how this was translated in the MOOC design and how it was experienced by the course participants. More details on the enactment of the courses can be found in Garreta-Domingo and Colas (2015).

Epistemic design: Through a project-based approach, participants designed an ICT-based learning activity ready to use in their own lessons. Taking Carvalho and Goodyear's (2017) service design lens to analyze the insights we gained in the intervention, we saw how at the base level of learning (what educators did according to themselves) our interventions were valued very positively and participants would both repeat and recommend the experience (Garreta-Domingo, Hernández-Leo, Mor & Sloep, 2015). Nevertheless, at the superposed level of managing their own learning, we saw how participating educators could not properly understand what was expected from them in the case of some design tasks (Garreta-Domingo, Sloep, & Hernández-Leo, under authors' revision).

For further implementations, the initial tasks of the course should more directly show the value of HCD by, for example, providing examples of good / bad design, through reflection on the design process, or the analysis of services or products from a HCD perspective. Moreover, HCD-specific language should be presented with more scaffolding (see Garreta-Domingo, Hernández-Leo, & Sloep, 2018).

Social design: The social dimension of learning had to cater for an open and large group formed by a multilingual audience from diverse educational sectors and disciplines. In both editions, participants expressed a heightened sense of community by the end of the course (Garreta-Domingo, Sloep, Hernández-Leo, & Mor, 2017). Albeit temporary, this sense was enough to 1) facilitate individual learning paces while leveraging the power of peers, and 2) move from a centrally facilitated to a decentralised, autonomous community. Thus, each participant could work on his/her design challenge; which also meant they all had a shared purpose that promoted peer interactions.

For further implementations, two key elements should be taken into account: 1) foresee and organise how the different paces and disciplinary sectors can be balanced out; 2) ensure that facilitators understand and have a good grasp of the HCD mindset, methods and processes.

Set design: The HANDSON MOOC was designed to expose educators to several ICT-tools; some that were part of taking the course, other that participants had to choose. The combination of the tools - showing how each can be used for a different purpose - did not represent a problem (Garreta-Domingo, Hernández-Leo, Mor, & Sloep, 2015). Interestingly, for example, was the evolution of the comfort level with the virtual learning environments: participants to the 1st edition started at a higher level of comfort with Moodle compared to the 2nd edition with Canvas. Nevertheless, by the end of the 5 weeks, the comfort level with the course platform increased more for the latter. A similar trend was observed in the comfort level with ILDE; which started very low in both editions but then had increased significantly by the end of the course. Despite the fact that the usage of different ICT tools did not represent an issue, the need to login separately to different environments did represent a barrier for many participants.

Thus, to our question '*Which form of epistemic, social and set design could structure the incorporation of HCD in the design for learning?'*, we state that the design of our intervention is an adequate form to introduce HCD in the design for learning. We have also mentioned in this subsection - and in the papers that conform this dissertation - the improvements that we think could help leverage even more the added value that HCD can bring to the design of learning activities.

B) Contributions to the incorporation of HCD for TEL design

As stated earlier, one of the goals of the dissertation were to inform the implementation of HCD in TEL. We do so by focussing on three intertwined aspects: 1) how to incorporate the HCD *mindset* in the design of TEL, 2) how to bring the HCD *process* in the design of ICT-based activities and educational technology; and 3) how to bring in HCD *methods* to the design for learning. The analysis of the results of the HANDSON MOOCs provide pointers on how to incorporate HCD in educators' design activities to provide them with more professional tools.

1. Incorporating the HCD *mindset* in the design of TEL

As "amateur" designers, participant educators showed some designerly concerns and tasks. Interestingly, more pedagogically-savvy educators tended to place the focus on the ICT-tool as opposed to the design activity. Whereas educators with little familiarity with pedagogical models and trends, were able to embrace and act according the to HCD mindset (Garreta-Domingo et al., *under authors' revision*).

We can interpret these findings in the light of how teachers' beliefs either hinder or facilitate technology use (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017); which we extrapolate to new design practices. Beliefs influence knowledge acquisition, interpretation of course content, and comprehension monitoring (Pajares, 1992). As a result, previous knowledge and experiences seem to have prevented our more pedagogically knowledgeable participants from adopting a HCD mindset.

Nevertheless, it is our belief that, through acquisition and (more) practice, HCD can help creating the necessary experiences to (re)shape educators' beliefs. It can occupy the "middle ground territory" between philosophy and pedagogical tactics (Goodyear, 2005) which is often complex and demanding in terms of design.

For future instances, educators should be repeatedly and iteratively exposed to HCD. Pedagogical beliefs tend to be persistent and formed by past experiences, thus, long-term (and embedded) professional development is needed in order to change teachers' pedagogical beliefs and practices (Tondeur et al., 2017). The willingness of the participants to repeat and recommend our one instance should be leveraged by researchers, practitioners or institutions willing to put in place HCD for the design of learning activities.

2. Including the HCD *process* in the design of ICT-based activities

Our intervention also aimed at solving many of the shortcomings that many professional development activities have: our focus was not on the theory or the technology but on a personal educational challenge that each educator wanted to address through the design of an ICT-based learning activity. This made the process much more relevant and meaningful to each participant and, therefore, useful for the desired outcome of the MOOC: to have an activity ready to implement. As reported by the participants of the second edition of the course, 80% of the final survey respondents said they had the intention to enact the activity and 20% said "no" or "not yet" (Garreta-Domingo et al., *under authors' revision*).

Nevertheless, we also saw how the pace of the MOOC was perceived as slow for some participants and how some did not really benefited from the step-by-step and iterative design approach. As mentioned earlier (under epistemic design), more exposure to HCD in current services / products, more examples on good / bad design and more reflection on the design process could help overcome these limitations of our intervention.

3. Including HCD *methods* in the design for learning

Participant educators had a hard time comprehending and acting on some of the HCD methods. While one may argue that some were not the best methods, given our research questions, we chose to incorporate widespread methods in the practice of HCD; notably "personas" and "heuristic evaluation". Personas is a method that explicitly emphasises the involvement of the human perspective from the beginning of the design lifecycle and, thus, serves well our research aims. However, considering the course characteristics, we opted for the lightweight version of proto-personas; which are based in the assumptions of designers, as opposed to real users' data. Heuristic evaluation is an inspection method based on a set of rules of thumb. The rationale for including this method was to bring the evaluation of the designs as early as possible.

We learned, through our interventions, that participants' general behaviour was to relate HCD methods to what was already known to them. For instance, we see how many "personas" were just a description of a real student rather than the intended archetypical ones (Garreta-Domingo et al, *under authors' revision*), and how many "heuristics" were turned into student evaluation rubrics rather than rules of thumb to evaluate their design (Garreta-Domingo et al., 2018).

For further implementations of HCD, we suggest to introduce the HCD methods without domain-specific jargon and provide more scaffolding for educators to properly comprehend and apply them in their learning practices.

Thus, to our question '*Is HCD practice directly transferable to the design practices of educators?',* our answer is that HCD is not as directly transferable as we had envisioned. From a critical perspective, we may say that we should have foreseen this outcome; or that we did not apply HCD for the design of our own intervention. We discuss this further in the Limitations section.

C) Contributions from a disciplinary perspective

This dissertation sits at the crossroads of learning design and technology-enhanced learning while also touching upon human-centered design, teacher training and educational technology. Thus, its value is in how these fields could work together both at the research and the practitioner levels. However, our contributions to each field independently can also be summarised as follows:

1. **Learning design:** As many authors (among others, Agostinho et al., 2011; McKenney et al., 2015) have claimed, there is a lack of empirical research to understand teachers' design practices. Our research contributes to this body of knowledge and reports how teachers design following a formal design process and implementing HCD methods. Thus, we also contribute to the idea of professionalising educators design activities (Laurillard, 2012).
2. **Technology-enhanced learning:** Focussing on an ICT-mediated learning activity, our interventions are an example of how educators should start with the problem space and only later move to the solution space. This approach will pave the way for the use of technology as a cognitive partner.
3. **Human-centered design:** Subscribing Carvalho and Goodyear's (2017) position, we believe that "education is a surprisingly neglected sector of activity in research (and practice) on service design (and all human-centered design variations) and innovation and that greater attention to education as a service (an a field of interest) can shed new light on theoretical (practical) and methodological issues in service design and innovation research." (in brackets, our additions). Thus, traditionally, HCD in education has focused on specific tools (i.e. tutoring systems, classroom design) and less in the myriad of designed activities for teaching and learning. Our dissertation brings a novel and, we contend, better approach to incorporate HCD in education.
4. **Teacher training:** The field of teacher training is extensive and active. Nevertheless, it has often been criticized on several accounts. We focus here on the mistaken focus on theories and tools and by being out of context and far from the teachers' practice (Verloop, van Driel, & Meijer, 2001). The HANDSON MOOCs

were two real teacher training interventions with high levels of satisfaction: in the second edition, 81% of participants gave it a grade of 8 or higher; complemented by the 90% of participants that would recommend the MOOC to a colleague/peer and the 95% that would be interested in a new edition of the course (Garreta-Domingo et al., *under auhtors' revision*). These data confirms that the HANDSON MOOC is a valuable continuous professional tool for educators and that it is not a one time course but one that can be taken as many times as the participant wants to design an ICT-based learning activity or course. The MOOC leverages the experience and expertise of peers and the design skills of educators.

5. **Educational technology:** The Next Generation of Digital Learning Environments published work points towards the right direction for educational technology. However, it is being pushed by technologists and their perspectives in education. Educators should be part of the NGDLE design from the onset. HCD can be the means for this to happen without requiring educators to shift their expertise. Teachers do not need to become experts in the design of educational technology, they need to design technology-enhanced learning and through these designs they will also have an impact of the conceptualization and implementation of technology.

We have summarised in this section the main contributions of the dissertation. We have also exposed how our work 1) extends and enhances the existing pool of empirical research on how to build on teacher expertise to support them in their design efforts; and 2) informs both practice and research in the fields of HCD, TEL, learning design, teacher training and educational technology. The specific interest of our study therefore lies in the insights it provides for both researchers and practitioners in these different fields but also at their crossroads.

2.4. Limitations

In this dissertation we propose to empower educators as designers to bring more coherence to the currently rather loosely organised and individually-oriented task of design for learning with ICT tools. To investigate our related research questions, we designed and implemented an authentic teacher training intervention. Before concluding, we compile here the limitations and challenges we encountered and which can guide potential future research work.

Pedagogical limitations. Our aim to design a genuine intervention that could reach out to a wide and international audience led us to the form of a MOOC. These type of courses have been widely researched and discussed and it is out of our scope to delve into it. However, we did face similar problems to other MOOCs: high numbers of dropouts, English as the vehicular language for the learning materials and environments, and an extra activity in the already busy lives of participants. As in any HCD project, we had to deal with several constraints, notably the 1) design of a real intervention meaningful and useful for our participants while 2) investigating our research questions. Thus, to encourage participation, we opted for a 5-week duration which - we knew - was short. We reduced to a minimum the introduction to HCD in favor of a hands-on and reflective approach. This resulted in a lack of onboarding and scaffolding to the mindset, process and methods.

Technological limitations. We had dropouts due to the course format but also because of the several environments we used for the enactment of the course. While some participants enjoyed the experience and this diversity made them feel more comfortable with ICT afterwards, we saw how several logins for different tools in order to follow the course was a barrier for many others. We also encountered initial technical problems with Canvas, which made first week activities difficult and could not export statistical data from this platform.

Methodological limitations. While we had several data sources to analyze, we did lack data from Canvas and could not collect all available data for further analysis. Also, due to the voluntarily participation to the MOOC (including answering the surveys), we could not gather as much data as we would have liked.

3. CONCLUDING REMARKS & FUTURE RESEARCH LINES

This dissertation explores the design as undertaken by teachers through the juxtaposition of human-centered design and technology-enhanced learning. The relevance of design for education is widely acknowledged. However, in line with the key ideas of HCD, our position stands out in that we emphasize that only *through its related mindset, processes and methods* design can play a key role in the creation of learning activities and of educational technology. We believe that only then design can integrate currently scattered but strongly interrelated activities. What does this imply for teachers?

Whereas most physical classrooms layouts and models resemble those of decades ago, the tasks of educators have been deeply affected by the changes in society. We might still encounter that odd educator who just uses a paper textbook for her teaching or keeps using the same written notes year after year to address her students. However, such educators now can only be the exception as the pressure from society on education is mounting and the adoption of technology is unavoidable. It is our belief that this push towards change in education - not only incremental but also disruptive - has mostly been done without adequate support. Instead, educators are being asked to take on so many more roles representing equally many different specialities that it is impossible for them - as individuals - to master them all.

Psychologist, conflict mediator, actor, counselor, coach, technologist, diversity expert, individual empowerment expert, and many other “hats” are pushed on educators. Networked learning is even pushing on more hats, as authors have identified roles such as “the collector”, “the curator”, “the alchemist”, “the programmer”, “the concierge”, to mention just a few of them (Downes, 2010; Siemens, 2008). These many roles have then to be interpreted within an ever-increasing complex classroom orchestration (Dillenbourg, 2011), that includes a number of tools and meso and macro levels requirements. Our claim is that this constant push to bring change through the micro-level of the teacher is unrealistic.

Nevertheless, traditionally, educators have worked almost always singly. Admittedly, they have to follow curriculum programmes and abide by both educational and institutional guidelines. However, they have mostly operated on their own in their daily practices. Moreover, the traditional tensions between education and technology are still present. Still many educators and educational researchers pride themselves on being pedagogically (as opposed to technologically) driven in their teaching and learning research and designs. Still most educational technology is developed without sufficient inputs from educators or educational sciences.

We have seen how educators approach the design of learning activities and lesson plans. Their practice-oriented, experience-based and mostly intuitive design activities call for a more systematic and professional approach. We have also seen how properly designed interventions can empower teachers as HCD designers. Our empirical research has provided insights in how educators can acquire a design mindset, follow a design process and apply HCD methods, albeit that they need practice with support through an applied learning process.

Therefore, we reaffirm our idea that HCD can bring coherence to the currently loosely organised and individually-oriented task of design for learning with ICT tools. Given that educators accomplish design tasks almost on a daily basis, they could - like many designers - benefit from a hands-on, multidisciplinary, collaborative and iterative approach, as advocated by the field of human-centered design. In fact, all actors in technology-enhanced learning design would benefit from such an approach. They may not approach design in the same way, some may not even call it design, but they all abide by Simon's (1996) maxim to *devise courses of action aimed at changing existing situations into preferred ones*.

That said, the design of technology-enhanced learning activities is strongly related to the affordances and features of (educational) technologies. Some, erroneously, still claim technology to be 'just a tool'; but technologies also influence and define the usage and this is even more relevant if one wants these tools to become cognitive tools. But, the near future holds promises: thanks to the flexibility, interoperability and distributed-nature of the next generation of digital learning environments any learning design could be supported. But for this to happen, we first need to design them. The foreseen software architecture allows for a Lego approach, but *someone* needs to decide which are the bricks and how they are to be put together.

As advocated by a human-centered design approach, this *someone* should be a multidisciplinary team. We cannot expect a single individual to master all components, that is, expect teachers to be jacks of all trade. It is the hands-on collaboration among disciplines that will allow for qualitatively high ranking and innovative learning designs, pedagogies and technologies. Educators, instructional designers and educational technologists need to find a common language and common processes. Heeding the maxims of human-centered design will facilitate the emergence of genuine technology-enhanced learning.

We envision, then, how a human-centered design approach will not only impact the design for learning but also the design of educational technology. The learning ecosystem is expected to be in continuous evolution and it is up to the *learning* processes and activities to guide this development. Both educators, designers and technologists need to leverage data-driven (qualitative and quantitative) approaches to enhance, inform and intertwine their design spaces.

Indeed, looking further forward we see how the design for learning and the design of educational technology go hand in hand. To make this become a reality, silos need to be broken down and all actors involved need to embrace multidisciplinarity. And this can only be achieved if processes, tools and language are shared. It is our belief that human-centred design as a philosophy and process facilitates these two essential changes.

Multidisciplinarity is a cornerstone of HCD in all its different representations and evolutions. For example, the idea of "sense & respond" (based on the Lean startup and Lean UX approaches, as discussed) is based on the existence of small and autonomous teams that have the capacity to learn - build - measure, thanks to a constant "conversation" with users.

Let's then imagine a scenario; one in which cross-functional teams define the design of technology-enhanced learning as well of educational technologies. The educator is the expert on her topic as well as on the classroom orchestration, but she works closely with expert instructional designers, UX designers and educational technology developers. The instructional designers contribute their expertise as pedagogical models. The UX designers are process facilitators, design enablers; they know the methods and they ensure that the user involvement is present at all project stages, they ensure a good user experience by having a holistic view of the different elements at play. The educational technologists are the experts on ICT tools or on the next generation digital learning environment; they are key in making the necessary changes in the technology.

These self-contained teams operate at a micro-level. For them to be successful, a shared mindset and common language, processes and tools are needed. HCD is an iterative process; through complete design lifecycles, solutions are conceptualized, defined, tested and improved. These life cycles vary in complexity and length. In a lean UX setting, the cycles are fast, we need to learn - build - measure in short periods of time because we're also working in self-contained problems. In a more traditional HCD process, the problems we address have a larger scope and weeks become months. In both cases, the results of the design life cycles shine through at the meso-level and progressively the same process, methods and mindset is applied for institution-wide aspects. And this, in turn, impacts the macro-level.

We can also expect another outcome to result from applying human-centered learning design with technology. Through the human-centered design processes and activities, teachers will learn differently and from these new collaborative, hands-on and iterative experiences they will be able to design new learning activities. As we have seen, educators design based on their beliefs and experiences and tend to fail in the initial and final analysis stages. Providing them with a context that allows them to learn differently, explore before designing and analyze the results before implementing, will have a rippling effect on their learning designs, educational technology and students. As opposed to asking them to become "Jack of all trades", educators would be surrounded by specialists that bring in new perspectives as well as empower them as the designers of learning.

How we see the contributions of this dissertation in terms of future research lines, we expose next. We use, as in our text, the micro, meso and macro levels approach.

Another iteration of the HANDSON MOOC. The course arose the interest of both practitioners and researchers. Still today we receive messages of people asking for another edition of the course or more information on the intervention. Through the papers compiled in this dissertation and the present essay we have provided pointers for the improvement of the epistemic, social and set designs to facilitate more iterations. We particularly see this line of research relevant for researchers in the field of learning design whose aim is to contribute to the body of knowledge on how educators design and could be empowered as designers. In the form of a MOOC, the intervention would still address the micro-level. However, we could also foresee institutions taking the HANDSON design for the training of their teachers.

The HANDSON approach for institutions. A research at the meso level would, for one, tackle another of the factors that affect teachers' design decisions (context of use); and also the practice of the HCD framework. Such an embedded and repeated initiative would forego some of the limitations we encountered with the MOOC. Moreover, this level could potentially facilitate the incorporation of the user perspective in the design process of educators. The meso level complies better with HCD principles as it would allow for iteration, refinement, user involvement and collaboration. However, at this level we might not yet have the environment to actually put in place the scenario depicted above.

HCD for the design of learning activities and the design of their supporting educational technology. We are aware of the difficulties of research at the macro-level. Yet, as we have exposed, it is there where we see that HCD could be more beneficial. It would not only promote iteration, refinement, user involvement and collaboration but contribute to shape the design of educational technology. For example, research-practice partnerships (RPPs) could be an opportunity for this to happen and, thus, contribute both to the practice and the research of 'educators as designers'.

Kappa Essay References

Agostinho, S., Bennett, S., Lockyer, L., & Harper, B. (2011). The future of learning design. *Learning, Media & Technology*, *36*(2), 97–99. http://doi.org/https://doi.org/10.1080/17439884.2011.553619

Amiel, T., & Reeves, Thomas, C. (2008). Design-Based Research and Educational Technology: Rethinking Technology and the Research Agenda. *Educational Technology & Society*, *11*(4), 29–40. http://doi.org/10.1590/S0325-00752011000100012

Anderson, T. (2009). The Dance of Technology and Pedagogy in Self-Paced Distance Education Terry Anderson, Canada Research Chair in Distance Education Athabasca University, Canada, 1–7.

Anderson, T., & Dron, J. (2011). Three generations of distance education pedagogy. *International Review of Research in Open and Distance Learning*, *12*(3), 80–97.

Anderson, T., Shattuck, J., & Brown, A. (2012). Design-Based Research: A Decade of Progress in Education Research? *Educational Researcher*, *41*(1), 16–25. http://doi.org/10.3102/0013189X11428813

Asensio-Pérez, J. I., Dimitriadis, Y., Pozzi, F., Hernández-Leo, D., Prieto, L. P., Persico, D., & Villagrá-Sobrino, S. L. (2017). Towards teaching as design: Exploring the interplay between full-lifecycle learning design tooling and Teacher Professional Development. *Computers and Education*, *114*, 92–116. http://doi.org/10.1016/j.compedu.2017.06.011

Bannan-Ritland, B. (2003). The Role of Design in Research: The Integrative Learning Design Framework, *32*(1), 21–24.

Bates, T. (2015). *Teaching in a Digital Age: Guidelines for Designing Teaching and Learning*. Vancouver, BC: Tony Bates Associates Ltd. Retrieved from http://opentextbc.ca/teachinginadigitalage/

Becta. (2008). *Harnessing Technology Review 2008: The role of technology and its impact on education*. Coventry, UK. Retrieved from http://webarchive.nationalarchives.gov.uk/20101105143633/http://publications.becta.org.uk/download.cfm?resID=38751

Bennett, S., Agostinho, S., & Lockyer, L. (2015). Technology tools to support learning design: Implications derived from an investigation of university teachers' design practices. *Computers & Education*, *81*, 211–220. http://doi.org/10.1016/j.compedu.2014.10.016

Boschman, F., McKenney, S., & Voogt, J. (2014). Understanding decision making in teachers' curriculum design approaches. *Educational Technology Research and Development*, *62*(4), 393–416. http://doi.org/10.1007/s11423-014-9341-x

Brown, M., Dehoney, J., & Millichap, N. (2015). The Next Generation Digital Learning Environment: A Report on Research, 11.

Brown, M., & Edelson, D. C. (2003). *Teaching as design: Can we better understand the ways in which teachers use materials so we can better design materials to support their changes in practice?* Evanston, IL.

Buchanan, R. (1992). Wicked Problems in Design Thinking. *Design Issues*, *8*(2), 5–21. http://doi.org/10.2307/1511637

Carvalho, L., & Goodyear, P. (2017). Design, learning networks and service innovation. *Design Studies*, 1–27. http://doi.org/10.1016/j.destud.2017.09.003

Cober, R., Tan, E., Slotta, J., So, H. J., & Könings, K. D. (2015). Teachers as participatory designers: two case studies with technology-enhanced learning environments. *Instructional Science*, *43*(2), 203–228. http://doi.org/10.1007/s11251-014-9339-0

Colas, J.-F., Sloep, P. B., & Garreta-Domingo, M. (2016). The effect of multilingual facilitation on active participation in MOOCs Authors: *IRRODL*, *17*(4). http://doi.org/10.1017/CBO9781107415324.004

Cooper, A. (2004). *The inmates are running the asylum: Why high-tech products drive us crazy and how to restore the sanity* (1st ed.). Indianapolis, IN, USA: Sams - Pearson Education.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). Los Angeles: SAGE Publications, Inc.

Cviko, A., McKenney, S., & Voogt, J. (2014). Teacher roles in designing technology-rich learning activities for early literacy: A cross-case analysis. *Computers and Education*, *72*, 68–79. http://doi.org/10.1016/j.compedu.2013.10.014

Dalziel, J., Conole, G., Wills, S., Walker, S., Bennett, S., Dobozy, E., … Bower, M. (2012). *The Larnaca declaration on learning design*. Retrieved from http://www.larnacadeclaration.org/

Dillenbourg, P., Zufferey, G., Alavi, H., Jermann, P., Do-lenh, S., & Bonnard, Q. (2011). Classroom Orchestration : The Third Circle of Usability - Why is Paper Highly Usable in Classrooms ? *CSCL 2011 Proceeding*, *I*, 510–517. Retrieved from http://infoscience.epfl.ch/record/168741/files/Classroom Orchestration: The Third Circle of Usability.pdf?version=1

Downes, S. (2010). The Role of the Educator. Retrieved from http://www.downes.ca/post/54312.

Doyle, W., & Ponder, G. A. (1977). The practicality ethic in teacher decision-making. *Interchange*, *8*(3), 1–12. http://doi.org/10.1007/BF01189290

Dron, J., & Anderson, T. (2016). The Future of E-learning. In Haythornthwaite. Caroline, R. Andrews, J. Fransman, & E. M. Meyers (Eds.), *SAGE Handbook of E-learning Research* (2nd ed., pp. 1–32). Sage.

Ertmer, P. (1999). Addressing first- and second-order barriers to change: strategies for technology integration. *Educational Technology Research and Development*, *47*(4), 47–61. http://doi.org/10.1007/BF02299597

Ertmer, P., & Ottenbreit-Leftwich, A. T. (2012). Removing obstacles to the pedagogical changes required by Jonassen's vision of authentic technology-enabled learning. *Computers and Education*, *64*, 175–182. http://doi.org/10.1016/j.compedu.2012.10.008

Ertmer, P., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers and Education*, *59*(2), 423–435. http://doi.org/10.1016/j.compedu.2012.02.001

Flavin, M., & Quintero, V. (2018). UK higher education institutions' technology-enhanced learning strategies from the perspective of disruptive innovation. *Research in Learning Technology*, *26*(1063519), 632–637. Retrieved from https://journal.alt.ac.uk/index.php/rlt/article/view/1987/

Garreta-Domingo, M., & Colas, J.-F. (2015). *Palm Reading of the HANDSON MOOC*. Barcelona. Retrieved from http://www.handsonict.eu/download/807/

Garreta-Domingo, M., Hernández-Leo, D., Mor, Y., & Sloep, P. B. (2015). Teachers' perceptions about the HANDSON MOOC: A learning Design Studio Case. In *Proceedings of the European Conference on Technology Enhanced Learning (EC-TEL)* (pp. 420–427). Springer. http://doi.org/https://doi.org/10.1007/978-3-319-24258-3_34

Garreta-Domingo, M., Hernández-Leo, D., & Sloep, P. B. (2018). Evaluation to support learning design: Lessons learned in a teacher training MOOC. *Australasian Journal of Educational Technology*, *33*(1). http://doi.org/https://ajet.org.au/index.php/AJET/article/view/3768

Garreta-Domingo, M., Sloep, P. B., Hernández-Leo, D., & Mor, Y. (2017). Editorial: Learning design for teacher professional development. *International Journal of Educational Technology in Higher Education*, *14*, 19–21. http://doi.org/10.1186/s41239-017-0074-x

Garreta-Domingo, M., Sloep, P., Hernández-Leo, D., & Mor, Y. (2017). Design for collective intelligence : Pop-up communities in MOOCs. *AI & Society*, *33*(1), 91–100. http://doi.org/10.1007/s00146-017-0745-0

Goodyear, P. (2015). Teaching as design. *HERDSA Review of Higher Education*, *2*, 27–50. Retrieved from http://www.herdsa.org.au/wp-content/uploads/HERDSARHE2015v02p27.pdf

Goodyear, P., & Carvalho, L. (2014). Framing the analysis of learning network architectures. In L. Carvalho & P. M. Goodyear (Eds.), *The Architecture of Productive Learning Networks* (pp. 48–70). New York and London: Routledge Falmer.

Gothelf, J., & Seiden, J. (2016). *Lean UX: Designing Great Products with Agile Teams*. O'Reilly Media.

Gothelf, J., & Seiden, J. (2017). *Sense and Respond: How Successful Organizations Listen to Customers and Create New Products Continuously*. Harvard Business Review Press.

Hermans, H., Janssen, J., Vogten, H., & Koper, R. (2015). Flexible provisioning for adult learners. *Journal of Universal Computer Science*, *21*(2), 206–222.

Hermans, H., Kalz, M., & Koper, R. (2014). Towards a learner-centred system for adult learning. *Campus-Wide Information Systems*, *31*, 2–13. http://doi.org/http://doi.org/10.1108/CWIS-07-2013-0029

Hermans, R., Tondeur, J., van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers and Education*, *51*(4), 1499–1509. http://doi.org/10.1016/j.compedu.2008.02.001

Hernández-Leo, D., Asensio-Pérez, J. I., Derntl, M., Pozzi, F., Chacón-Pérez, J., Prieto, L. P., & Persico, D. (2018). An Integrated Environment for Learning Design. *Frontiers in ICT*, *5*(9). http://doi.org/10.3389/fict.2018.00009

Hernández-Leo, D., Moreno, P., Chacón, J., & Blat, J. (2014). LdShake support for team-based learning design. *Computers in Human Behavior*, *37*, 402–412. http://doi.org/10.1016/j.chb.2012.05.029

Hoogveld, A., Paas, F., Jochems, W., & Merrienboer, J. van. (2002). Exploring teachers' instructional design practices from a systems design perspective. *Instructional Science*, *30*(4), 291–305. http://doi.org/10.1023/A:1016081812908

ISO. (2009). Ergonomics of human system interaction – Part 210: Human-centred design for interactive systems (ISO 9241-210:2010; formerly known as 13407). *International Organization for Standardization*.

Janssen, F., Westbroek, H., Doyle, W., & Driel, J. Van. (2013). How to make innovations practical. *Teachers College Record*, *115*(7), 1–42.

Jonassen, D. H., Carr, C., & Yueh, H.-P. (1998). Computers as mindtools for engaging learners in critical thinking. *TechTrends*, *43*(2), 24–32. http://doi.org/10.1007/BF02818172

Jonassen, D. H., & Reeves, Thomas, C. (1996). Learning wth technology: using computers as cognitive tools. *Handbook of Research for Educational Communications and Technology*.

Kali, Y., Goodyear, P., & Markauskaite, L. (2011). Researching design practices and design cognition: contexts, experiences and pedagogical knowledge-in-pieces. *Learning, Media and Technology*, *36*(2), 129–149. http://doi.org/10.1080/17439884.2011.553621

Kali, Y., McKenney, S., & Sagy, O. (2015). Teachers as designers of technology enhanced learning. *Instructional Science*, *43*(2), 173–179. http://doi.org/10.1007/s11251-014-9343-4

Kirkwood, A., & Price, L. (2016). Technology-enhanced learning and teaching in higher education : what is “ enhanced ” and how do we know ? A critical literature review, *9884*(May), 1–44. http://doi.org/10.1080/17439884.2013.770404

Könings, K. D., Brand-Gruwel, S., & van Merriënboer, J. J. G. (2007). Teachers' perspectives on innovations: Implications for educational design. *Teaching and Teacher Education*, *23*(6), 985–997. http://doi.org/10.1016/j.tate.2006.06.004

Könings, K. D., Seidel, T., & van Merriënboer, J. J. G. (2014). Participatory design of learning environments: Integrating perspectives of students, teachers, and designers. *Instructional Science*, *42*(1), 1–9. http://doi.org/10.1007/s11251-013-9305-2

Kop, R., & Fournier, H. (2013). Developing a framework for research on personal learning environments. *eLearning Papers*, *35*(November), 1–16.

Kreijns, K., Van Acker, F., Vermeulen, M., & Van Buuren, H. (2013). What stimulates teachers to integrate ICT in their pedagogical practices? the use of digital learning materials in education. *Computers in Human Behavior*, *29*(1), 217–225.

Kreijns, K., Vermeulen, M., Kirschner, P. A., van Buuren, H., & van Acker, F. (2013). Adopting the Integrative Model of Behaviour Prediction to explain teachers' willingness to use ICT: A perspective for research on teachers' ICT usage in pedagogical practices. *Technology, Pedagogy and Education*, *22*(February), 55–71. http://doi.org/10.1080/1475939X.2012.754371

Kuniavsky, M. (2003). *Observing the user experience: a practitioner's guide to user research* (1st ed.). Morgan Kaufman Publishers, Elsevier.

Laurillard, D. (2012). *Teaching as a Design Science: Building Pedagogical Patterns for Learning and Technology*. New York and London: Routledge.

Lockyer, L., Heathcote, E., & Dawson, S. (2013). Informing pedagogical action: Aligning learning analytics with learning design. *American Behavioral Scientist*, *57*(10), 1439–1459. http://doi.org/10.1177/0002764213479367

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining Pedagogical Content Knowledge: The construct and its implications for science education* (pp. 95–132). New York, Boston, London, Dordrecht, Moscow: Kluwer Academic Publishers.

Matuk, C. F., Linn, M. C., & Eylon, B. S. (2015). Technology to support teachers using evidence from student work to customize technology-enhanced inquiry units. *Instructional Science*, *43*(2), 229–257. http://doi.org/10.1007/s11251-014-9338-1

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

Merriman, J., Coppeto, T., Santanach-Delisau, F., Shaw, C., & Aracil, X. (2016). Next Generation Learning Architecture. Retrieved from http://hdl.handle.net/10609/47481

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054. http://doi.org/10.1111/j.1467-9620.2006.00684.x

Mor, Y., Craft, B., & Hernández-Leo, D. (2013). The art and science of learning design (editorial). *Research in Learning Technology*, *21*(22513), 1–8. http://doi.org/http://dx.doi.org/10.3402/rlt.v2li0.22513

Mor, Y., & Mogilevsky, O. (2013). The learning design studio: collaborative design inquiry as teachers' professional development. *Research in Learning Technology*, *21*(1), 1–15. http://doi.org/https://doi.org/10.3402/rlt.v21i0.22054

Norman, D. A. (2013). *The Design of Everyday Things: Revised and Expanded Edition*. Basic Books.

OECD. (2015). *Students, Computers and Learning; making the connection*.

Opfer, V. D., & Pedder, D. (2011). Conceptualizing Teacher Professional Learning. *Review of Educational Research*, *81*(3), 376–407. http://doi.org/10.3102/0034654311413609

Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information Systems Research*, *2*(1), 1–28. http://doi.org/10.1287/isre.2.1.1

Pajares, M. F. (1992). Teachers' beliefs and educational research: cleaning up a messy construct. *Review of Educational Research*, *62*(3), 307–332.

Pardo, A., Ellis, R. a., & Calvo, R. a. (2015). Combining observational and experiential data to inform the redesign of learning activities. *Proceedings of the Fifth International Conference on Learning Analytics And Knowledge - LAK '15*, 305–309. http://doi.org/10.1145/2723576.2723625

Penuel, W. R., Fishman, B. J., Haugan Cheng, B., & Sabelli, N. (2011). Organizing Research and Development at the Intersection of Learning, Implementation, and Design. *Educational Researcher*, *40*(7), 331–337. http://doi.org/10.3102/0013189X11421826

Postareff, L., Katajavuori, N., Lindblom-Ylänne, S., & Trigwell, K. (2008). Consonance and dissonance in descriptions of teaching of university teachers. *Studies in Higher Education*, *33*(1), 49–61. http://doi.org/10.1080/03075070701794809

Rahman, N., & Dron, J. (2012). Challenges and opportunities for learning analytics when formal teaching meets social spaces. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge - LAK '12* (pp. 54–58). New York, New York, USA: ACM Press. http://doi.org/10.1145/2330601.2330619

Rajagopal, K., Van Bruggen, J. M., & Sloep, P. B. (2017). Recommending peers for learning: Matching on dissimilarity in interpretations to provoke breakdown. *Educational Technology*, *48*(2), 385–406. http://doi.org/10.1111/bjet.12366

Reeves, Thomas, C. (2006). Design research from a technology perspective. In *Educational design research* (pp. 52–66).

Reimer, Y. J., & Douglas, S. A. (2003). Teaching HCI Design With the Studio Approach. *Computer Science Education*, *13*(3), 191–205. http://doi.org/10.1076/csed.13.3.191.14945

Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. Currency.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169. http://doi.org/10.1007/BF01405730

Ritter, F. E., Baxter, G. D., & Churchill, E. F. (2014). Foundations for Designing User-Centered Systems. *Foundations for Designing User-Centered Systems*, 33–54. http://doi.org/10.1007/978-1-4471-5134-0

Roschelle, J., & Penuel, W. R. (2006). Co-design of innovations with teachers: Definition and dynamics. *… of the 7Th International Conference on …*, 606–612. Retrieved from http://dl.acm.org/citation.cfm?id=1150122

Sanders, E. B.-N. (2006). Scaffolds for building everyday creativity. In J. Frascara (Ed.), *Designing effective communications: creating contexts for clarity and meaning* (pp. 65–77). New York, New York, USA: Allworth Press.

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign*, *4*(1), 5–18. http://doi.org/10.1080/15710880701875068

Schön, D. A. (1983). *The Reflective Practitioner; How Professionals Think in Action*. USA: Basic Books.

Sergis, S., & Sampson, D. G. (2017). Teaching and Learning Analytics to Support Teacher Inquiry : A Systematic Literature Review Learning analytics (pp. 25–64). http://doi.org/10.1007/978-3-319-52977-6

Shrader, G., Williams, K., Lachance-Whitcomb, J., Finn, L. E., & Gomez, L. (2001). Participatory design of science curricula: The case for research for practice. In *Annual Meeting of the American Educational Research Association*. Seattle, WA.

Shulman, L. S. (1986). Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher*, *15*(2), 4–14. http://doi.org/10.3102/0013189X015002004

Siemens, G. (2008). *Learning and Knowing in Networks: Changing roles for Educators and Designers*. Retrieved from http://www.academia.edu/2857165/Learning_and_knowing_in_networks_Changing_roles_for_educators_and_designers.

Simon, H. A. (1996). *The Sciences of the Artificial* (3rd ed.). Cambridge, MA: MIT Press.

Sloep, P. B. (2013). Networked professional learning. In A. Littlejohn & A. Margaryan (Eds.), *Technology-enhanced Professional Learning: Processes, Practices and Tools* (pp. 97–108). London: Routledge. Retrieved from http://hdl.handle.net/1820/5215

Stark, J. S. (2000). Planning introductory college courses: content , context and form. *Instructional Science*, *28*, 413–438. http://doi.org/10.1023/A:1026516231429

Stickdorn, M., & Schneider, J. (2012). *This is Service Design Thinking: Basics, Tools, Cases*. Wiley.

Stoyanov, S., Sloep, P. B., De Bie, M., & Hermans, V. (2014). Teacher-training, ICT, Creativity, MOOC, Moodle - What pedagogy? In L. Gómez Chova, A. López Martínez, & I. Candel Torres (Eds.), *Proceedings of Edulearn 14, the Sixth International Conference on Education and New Learning Technologies (EDULEARN 14)* (pp. 5678–5686). Barcelona, Spain: IATED Academy, IATED Digital Library. Retrieved from http://hdl.handle.net/1820/5463

Svihla, V., Reeve, R., Sagy, O., & Kali, Y. (2015). A fingerprint pattern of supports for teachers' designing of technology-enhanced learning. *Instructional Science*, *43*(2), 283–307. http://doi.org/10.1007/s11251-014-9342-5

Tondeur, J., van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence. *Educational Technology Research and Development*, *65*(3), 555–575. http://doi.org/10.1007/s11423-016-9481-2

Verloop, N., van Driel, J. H., & Meijer, P. (2001). Teacher knowledge and the knowledge base of teaching. *International Journal of Educational Research*, *35*(5), 441–461. http://doi.org/10.1016/S0883-0355(02)00003-4

Vogten, H., & Koper, R. (2014). Towards a new generation of Learning Management Systems. *6th International Conference on Computer Supported Education*, (April).

Voogt, J., Laferrière, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. (2015). Collaborative design as a form of professional development. *Instructional Science*, *43*(2), 259–282. http://doi.org/10.1007/s11251-014-9340-7

Wasson, B., Hansen, C. J., & Netteland, G. (2016). Data Literacy and Use for Learning when using Learning Analytics for Learners. In *LAK 2016*. Edinburgh. Retrieved from http://ceur-ws.org/Vol-1596/paper6.pdf

Williams, A. (2009). User-centered design, activity-centered design, and goal-directed design. *Proceedings of the 27th ACM International Conference on Design of Communication - SIGDOC '09*, 1–8. http://doi.org/10.1145/1621995.1621997

Wilson, S., Johnson, M., & Sharples, P. (2007). Personal Learning Environments : challenging the dominant design of educational systems . *Je-LKS - Journal of E-Learning and Knowledge Society*, *3*(2), 27–38. http://doi.org/10.1080/10494820701772652

Winograd, T. (1990). What Can We Teach About Human-Computer Interaction. In *CHI'90 Proceedings* (pp. 443–449). New York, NY. http://doi.org/10.1145/97243.97322

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Human-centred design to empower ‘teachers as designers’

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Abstract

Educators of all sectors are learning designers, often unwittingly. To succeed as designers, they need to adopt a design mindset and acquire the skills needed to address the design challenges they encounter in their everyday practice. Human-centred design (HCD) provides professional designers with the methods needed to address complex problems. It emphasises the human perspective throughout the design lifecycle and provides a practice-oriented approach, which naturally fits educators’ realities. This research reports the experiences of educators who used HCD to design ICT-based learning activities. A mixed methods approach was used to gauge how participating educators experienced the design tasks. The perceived level of difficulty and value of the various methods varied, revealing significant differences between educators according to their level of knowledge of pedagogy frameworks. We discuss our findings from the vantage point of educators’ pedagogical beliefs and how experience shapes these. The results support the idea that HCD is a valuable framework for educators, one that may inform ongoing international efforts to shape a science and practice of learning design for teaching.

Keywords

learning design, human-centred design, learning design studio, design framework, design lifecycle

Practitioner notes

What is already known about this topic

· The role of design in education is gaining attention.
· Educators are de-facto designers but lack sufficient knowledge of design processes and methods.
· The studio-based teaching concept fits naturally with teaching human-centred design (HCD).

What this paper adds

· Insights in the application of the HCD process and methods in a teacher training environment.
· Insights in how to support educators in acquiring a design mindset.
· Insights in how educators perceive HCD as a process and insights in HCD methods.

Implications for practice and/or policy

· For learning design researchers: directions in which way they can further advance their field.
· For learning design practitioners: considerations on how to support educators in acquiring a design mindset and design skills.
· For policymakers and educational institution administrators: guidance for setting up teacher professional development.

Introduction

It is commonly accepted that educators (teachers) are designers of learning opportunities (Bennett, Agostinho, & Lockyer, 2016). Much as in design, teaching is a highly complex activity that draws on many kinds of knowledge (Mishra & Koehler, 2006). Teaching also occurs in ill-structured, dynamic environments and, as a result, deals with so-called wicked problems. As in design, teaching is iterative: there is continuous enactment and subsequent tweaking of activities and resources (Sloep, 2013). Despite these similarities, little research has been devoted to the potential benefits for learning design of modern design insights (Carvalho & Goodyear, 2017). This paper focuses on a particular approach to design: human-centred design (HCD). *Our key hypothesis is that the design practices of educators benefit will from including HCD practices*.

Human-centred design (HCD) provides professional designers with a process as well as methods needed to address complex (wicked) problems. It is a design philosophy which emphasises a holistic approach to design, it aims to humanise both process and results (Norman, 2013). HCD is a practice-oriented, context-aware, empathetic and incremental framework. As such it naturally fits educators' realities.

Grounded in the idea that established design professions have methods that are useful in educational practice (Goodyear, 2015), we believe that HCD can become a useful approach to provide educators with the design skills they are reportedly lacking (Mor, Craft, & Hernández-Leo, 2013). Underlying this approach is the idea that educators could easily adopt HCD-inspired methods and practices by conceiving of themselves as learning designers and focusing on the practical process of devising effective learning experiences (Beetham & Sharpe, 2013).

Albeit that some authors report the need of more empirical research on how teachers design - to which this study aims to contribute-, there is already an increasing body of knowledge on ‘teachers as designers’. Three main underlying considerations seem to affect the design for learning: 1) teachers’ pedagogical beliefs and experiences, 2) teachers’ perceptions of students, and 3) contextual factors. We focus in this paper on the first consideration only, as there is a strong relationship between teachers' educational beliefs and their instructional decisions, planning and classroom practices (Beijaard & De Vries).

Teachers’ beliefs operate very much at an unconscious level and are deeply rooted; thus, some authors argue that teachers' beliefs about education are difficult if not impossible to change (Pajares, 1992). In contrast, we assume that teachers' pedagogical beliefs may be changed; however, the nature of the change depends very much on the content and nature of the influences a teacher undergoes (Beijaard & De Vries, 1997; Ertmer & Ottenbreit-Leftwich, 2010; Wright, 1997). Indeed, there is a bi-directional relationship between pedagogical beliefs and technology use (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). Therefore, teachers’ experiences with technology can become enablers for pedagogical belief change. It is in particular these ‘experiences’ that we aim to influence by exposing educators to the HCD mindset, methods and process.

The plausibility of our main hypothesis thus critically hinges on the answers to three research questions, each forming a topic of investigation of its own:

Topic 1. How do educators perceive a learning design process conceptualised as a HCD process?
Topic 2. How do educators perceive HCD-based design tasks?
Topic 3. To what extent do educators make proper use of the HCD methods and process?

To investigate these questions we set up an intervention in the form of a MOOC. The course was designed to allow participants to experience a HCD cycle through a hands-on and project-based approach. For that, a variety of quantitative and qualitative data is collected and analysed on the three topics by inspecting a number of surveys participating teachers filled out, by scrutinising the artefacts they designed and the comments they made in the MOOC forums. The findings from our study should be relevant for researchers, practitioners and educational institutions who are currently designing frameworks, activities and tools to enhance educators’ design skills.

Methodology

The research context: the HANDSON MOOC

The context for our research into the three topics is a Massive Open Online Course (MOOC). It covers an issue many teachers struggle with: the inclusion of ICT in education (OECD, 2015) and was intended to offer a genuine professional development opportunity for educators of all educational levels (Garreta-Domingo, Sloep, Hernández-Leo, & Mor, 2017). The HANDSON MOOC - implemented under a

Lifelong Learning Programme project (http://www.handsonict.eu/) - was open and free. Following Goodyear and Carvalho's Activity-Centred Analysis and Design (ACAD) model (Goodyear & Carvalho, 2014; Carvalho & Goodyear, 2017), the MOOC has 'set', 'social' and 'epistemic' design dimensions. The MOOC was offered twice (Spring and Autumn 2014). In this paper we focus on the second edition only.

The *set design* of the MOOC included Canvas as the course platform; it contained the syllabus, the design tasks as well as the discussion forums. The Integrated Learning Design Environment (ILDE) was the design platform; this web platform allows communities of educational designers to co-create and share learning designs both from scratch or by using the templates provided (Hernández-Leo, Asensio-Pérez, Derntl, Prieto, & Chacón, 2014).

The MOOC's *social design* comprised interaction with facilitators and peers in the forums and through weekly synchronous sessions. Since the MOOC was offered in seven languages in parallel, 15 volunteer facilitators addressed the students in their native language. Knowledgeable in online learning but with no formal HCD expertise, their role was to act as process managers for the participants. English was used for instructions and general communications only.

The *epistemic design* was grounded in the idea of a learning design studio (Mor & Mogilevsky, 2013; Reimer & Douglas, 2003; Winograd, 1990). In such a model, the main activity is the students' continued work on a design challenge, which they research and for which they devise innovative means of addressing it. In our case, participants individually designed an ICT-based learning activity that by the end of the course was intended to be ready for enactment in their own teaching setting. As per the *social* and *set designs*, the input from facilitators and peers was an essential element of the course experience and the learning process.

The course design: the design tasks

The epistemic design of the HANDSON MOOC counts 24 learning activities (Figure 1), which mimic a HCD process from considering the user requirements, to conceptualising the solution and, then, testing it on each iteration. For the key design tasks (A3, A6, A7, A8, A11, A14, A23), the participants' work was guided through ILDE design templates which provided a hands-on and lightweight approach to HCD techniques.

Design Studio for ICT-based Learning Activities - HANDSON MOOC (2)

Week 1: Initiate **Learning goals:** Get acquainted with LDS and define an initial version of the educational challenge.	A1: Introduction to the Design Studio for ICT-based Learning Activities! A2: Set up your Design Studio Journal. It is a tool for you! A3: ILDE Account and Dream Bazaar A4: Peer-mentoring - your dream!
Week 2: Investigate **Learning goal:** Get acquainted and apply HCD methods for user needs analysis. Review educational challenge based on peer feedback.	A5: Get familiar with the persona concept A6: Create your own persona A7: Analyzing context, factors and concerns A8: The objectives of your ICT-based learning activity A9: Revisit your dream and update it A10: Peer-mentoring - Your personas!
Week 3: Inspire & Ideate **Learning goal:** Continue user needs analysis and shaping the learning activity. Start thinking on monitoring the experience.	A11: Define the heuristics for your design project A12: Search for existing ICT-based learning activities A13: Learn about user scenarios A14: Ideate through writing a user scenario A15: Peer-mentoring - The objectives
Week 4: Prototype **Learning goal:** Translate the results of previous tasks into a prototype and assess it with a user or peer.	A16: Prototype your artifact A17: Revisit and update your evaluation heuristics A18: Test your prototype *Advanced authoring and implementation* A19: Consolidate your prototype A20: Peer-mentoring - Consolidate your prototype
Week 5: Evaluate & Reflect **Learning goal:** Receive peer feedback on the design activity. Reflect on the course.	A21: Publish your learning activity A22: Peer-mentoring - Your learning activity A23: Your design studio report A24: Reflect and share your thoughts!

Figure 1: The HANDSON MOOC’s (2nd edition) course activities

Given our goals, we chose to incorporate widespread methods in the practice of HCD; notably “personas” and “heuristic evaluation”. Personas is a method that explicitly emphasises the involvement of the human perspective from the beginning of the design lifecycle and, thus, fits well our research hypothesis. However, taking into account the MOOC’s characteristics we opted for a lightweight version: proto-personas; they are grounded in the assumptions of designers, as opposed to in real users’ data. Heuristic evaluation is an inspection method based on a set of rules of thumb. The rationale for including this method was to expose participants to the evaluation of their designs as early as possible.

The analysis: data collection, participants and techniques

To answer our three research questions, our study is framed within an interpretative research paradigm (Orlikowski & Baroudi, 1991). The study is exploratory, focuses on one particular authentic teacher training context (the HANDSON MOOC), and relies mainly on qualitative evidence (Asensio-Pérez et al, 2017). However, to provide more context (in particular trends), our research design follows a concurrent, embedded, mixed-methods strategy (Creswell, 2014).

Topic 1 - Perception of the design process: Data collection, participants and analysis techniques

The answer to the question under the topic 1 (perception of the design process as an HCD process) came from surveys (see Appendix for more details). The quantitative data was analysed with descriptive statistics using R software package (version 3.4.2, downloadable from https://cran.r-project.org/).

A total of 380 educators filled in the initial survey [preMOOC]. 66% were female and 34% male. Although participants came from all over the world, three countries represent more than 55% of them: 27% from Spain, 14% from Greece and 13% from Bulgaria. 52% reported to have a master's degree, 18% a bachelors, 12% a PhD and 10% initial teacher education. The number of years they had been teaching ranged between 0 and 50, with a mean of 13.9 (std. dev. 9.46). The educational level they were teaching at (more than one option was possible): 34% higher education, 33% secondary education, 21% adult education, 21% primary education, 16% teacher training and 12% vocational education.

A total of 83 educators filled in the final survey [postMOOC]. 80% were female and 20% male. Although again participants came from all over the world, three countries represent more than 74% of the respondents: 28% from Bulgaria, 24% from Spain and 22% from Greece. 63% declared to have a master's degree, 5% a bachelor's degree, 5% initial teacher education and 5% also a PhD. The number of years they had been teaching ranged between 0 and 35; mean 15.6 (std. dev. 8.69). Regarding the educational level they were teaching at (more than option was possible): 44% secondary teaching, 30% higher education, 23% primary education, 17% teacher training, 15% adult and 7% vocational education.

Topic 2 - Feedback on course activities: Data collection, participants and analysis

The same data sources ([preMOOC], [postMOOC], [weekly]) were also used to answer the question under topic 2 (feedback on design methods). This quantitative data was also analysed with R as the software package.

The quantitative feedback the participants gave on the course concerns all its design tasks. In the present context we took a closer look at one of them only. Week 2 included two persona-related activities and the analysis is based on the answer to the [weekly] question "Will you use the persona concept again?" and on an open text field where participants could answer the question "How do you think you might use the personas concept in your work?".

The 48 comments left by participants in the weekly survey (week 2) were classified in categories based on an analysis of their content. The categories that emerged from the data are listed in Table 1 and are used to drive our analyses (reported in the Results section below).

Table 1: Overview of categories of answers. These categories arose from the participants' qualitative data regarding the personas' concept

Category	**Example**
Will not use the concept again	"Now I have no idea", "I will not use it"
Might use the concept again but unclear how	"Whenever I have to create a project of ICT based learning", "Will try to assume solutions in everyday teaching problems and plan my objectives and actions according to the concept of the personas"
Equals the concept of "persona" to an individual student	"In identifying each of my students", "To know about the needs and requirements of my students personas will be very helpful. I can base my teaching on it to fulfil the needs of my students."
Will use it as "personas" are used	"To clearly define the target group of my online trainings", "When creating scenarios and templates of SCORM-based eLearning courses"
The concept is seen as something they already do	"I think teachers with a long teaching experience have been making use of personas although we have been unaware of it. We used to name our "personas" "kind of students" and to my poor opinion this is how we 'll keep on using the personas concept."

Topic 3 - Acquisition of HCD: Data collection, participants and analysis

The participating educators that formed the Catalan group informed topic 3 (proper use of HCD). We focus on them as they all completed the HANDSON MOOC and then enacted the designed ICT-based learning activity in their classrooms. Both activities together gave them Personal Education points (PE Points) officially recognised by the Catalan Department of Education. We only studied cases for which we could analyse the complete experience (Table 2).

Table 2: Data extracted from the Catalan group of participants only. Participants used Catalan in their designs, comments and evidences. Quotes have been translated to English by the principal researcher.

Data source	**Description**
ILDE designs	The artefacts created through ILDE templates.
Comments on forums	The comments participants made in the forums.
Enactment evidences	Participants had to enact the activity in their classrooms and provide evidences of the experience which also included reflections on the experience.
Surveys (preMOOC, postMOOC)	*See Figure 4*

For the analysis of these individual experiences, each user (Table 3) was analysed independently but similarly. For each, available data was consolidated in a single document. We carried out an expert review of their artefacts and took into account their survey responses. The resulting analysis has a narrative format summarising the key points (see data statement to access these documents). From this long description, the main findings for each particular participant were extracted and, from these, a short description was prepared.

Table 3: Summary of the characteristics of the six Catalan participants. Participant names are fictitious.

Name	Gender	Highest degree	Educational level	Modality of teaching	Years of teaching
Jordi	Male	Master	Secondary education	Face to face	5
Anna	Female	Master	Primary education	Face to face with some support of ICT tools	6
Maria	Female	Master	Primary education	Face to face	9
Sergi	Male	Initial teacher education	Vocational education	eLearning (through online environments only)	1 as an online teacher 8 in face to face settings
Bruna	Female	Master	Secondary education	Face to face with some support of ICT tools	12
Alba	Female	Initial teacher education	Primary education	Face to face	1

Results

Topic 1: Perception of the design process

Participants reported to join the MOOC in order to learn about ICT tools for teaching (85% of the respondents to the [preMOOC]). They listed Learning Design second (74%). At the end of the course, participants very much agreed that the course helped them meet these goals. To the question “How useful was the MOOC to learn about ICT tools”, 90% of respondents answered “useful” or “very useful”. A similar degree of agreement was reported on the usefulness of the course “to learn about the Learning Design Studio” (LDS) (91% for “useful” or “very useful”).

At the start of the course, a high percentage of participants declared to have a novice understanding and knowledge of Learning Design (53% were novice or almost novice, 26% neither novice nor expert, 18% almost experts and 3% experts) [preMOOC]. The level of comfort with LDS increased throughout the course, from 47% in week 1 to 84% in week 5 (Figure 2). Given that only 21% considered themselves knowledgeable in LDS at the onset and 60% report to have never heard about it before (Figure 3), we consider these results to indicate that the comfort level did indeed increase.

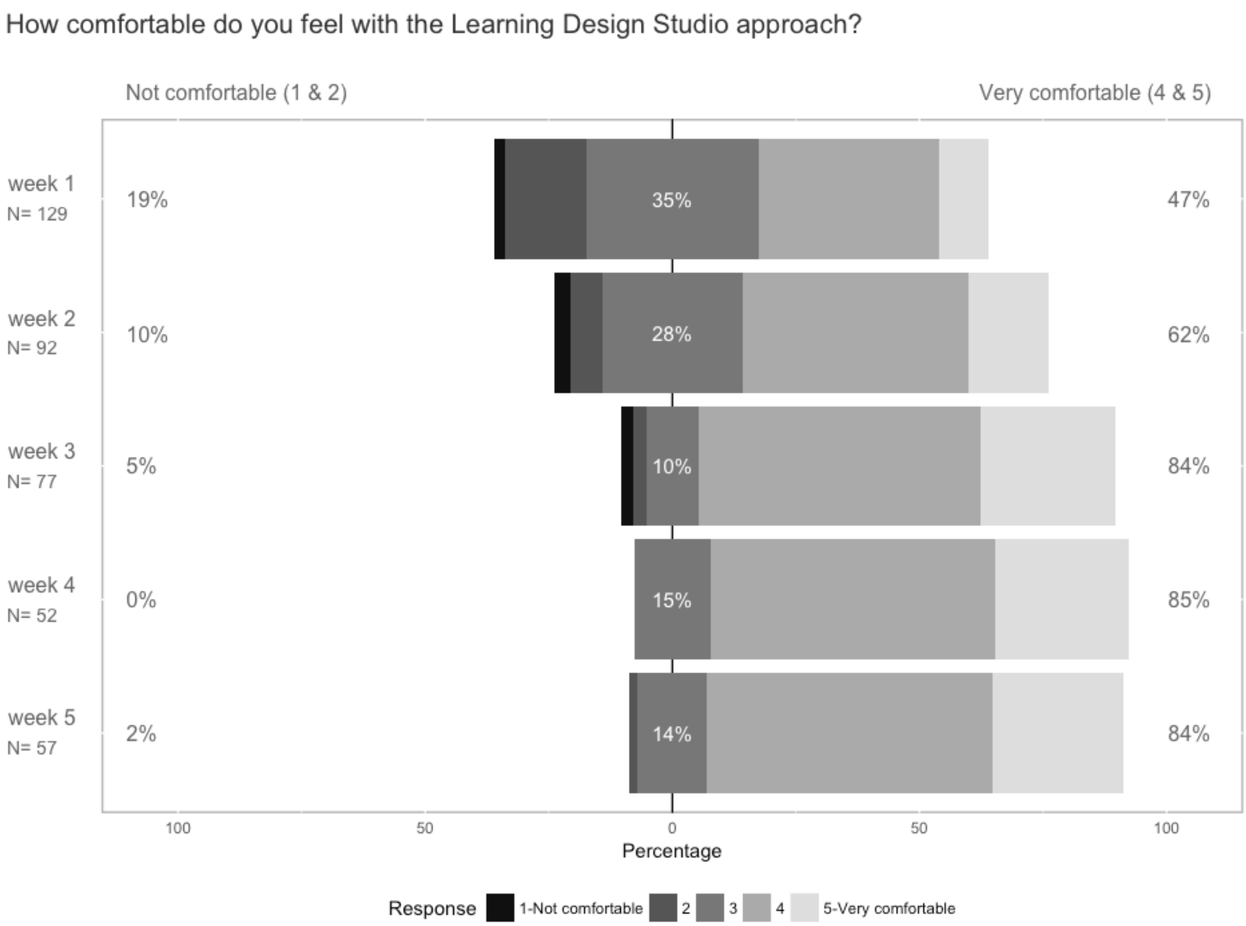

Figure 2: Participants answers to the question “How comfortable do you feel with: Learning Design Studio approach” in the weekly surveys.

Analysing in more detail the participants’ perceptions of the Learning Design Studio (Figure 3), we can see that they found LDS a relevant resource to include ICT in education and a useful methodology to design learning activities [postMOOC].

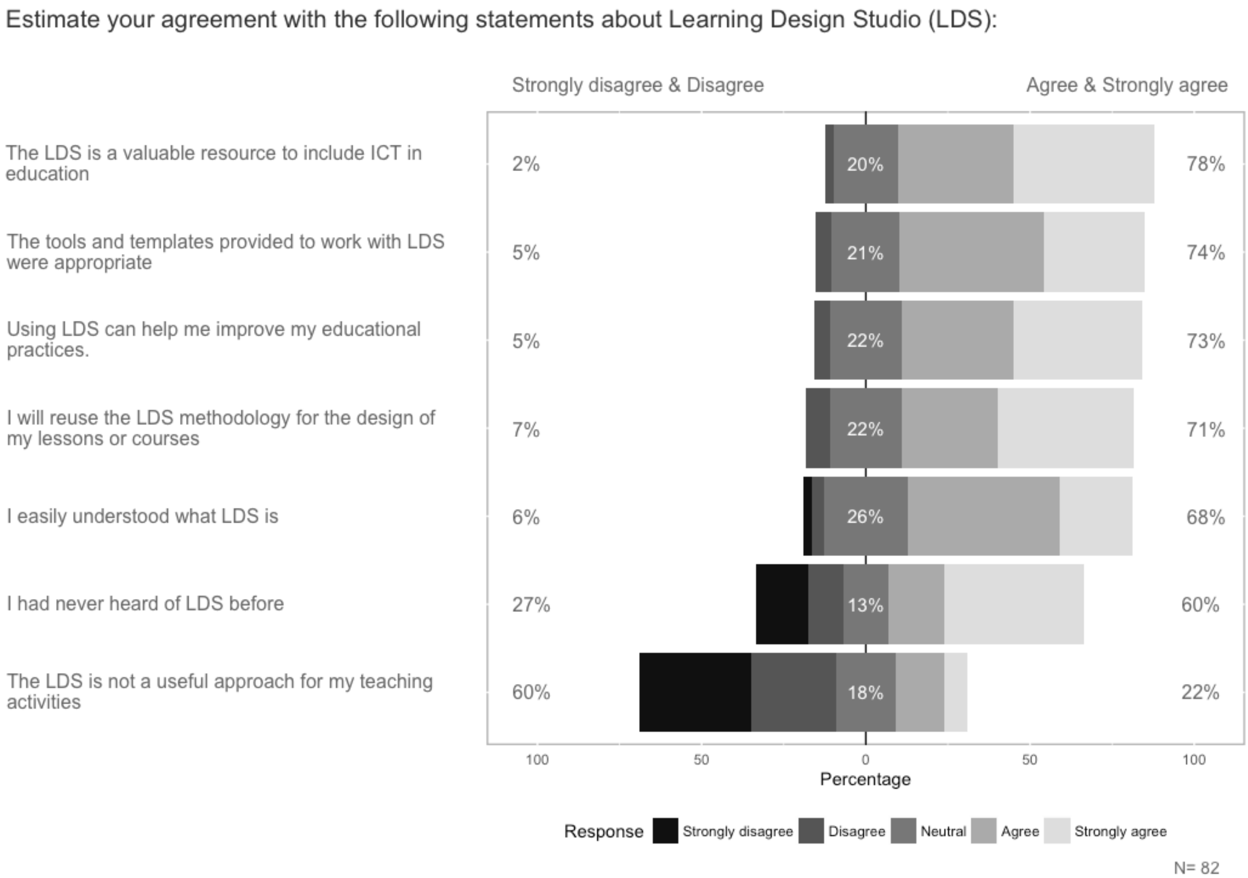

Figure 3: Level of agreement with the statements related to learning design [postMOOC]

The high satisfaction with the MOOC (81% gave it a grade of 8 or higher) is in line with the 90% of participants that would recommend the HANDSON MOOC to a colleague/peer and the 95% that would be interested in a new edition of the course (all [postMOOC] questions).

Topic 2: Feedback on course activities

For topic 2, we analysed the answers to the weekly surveys, given after accomplishing the weekly design tasks (Figure 1 and 4), and [postMOOC] surveys. The course outcome was a ready-to-implement ICT-based learning activity. In the final week survey, 80% of the respondents said they had the intention to enact the activity and 20% said “no” or “not yet” [weekly].

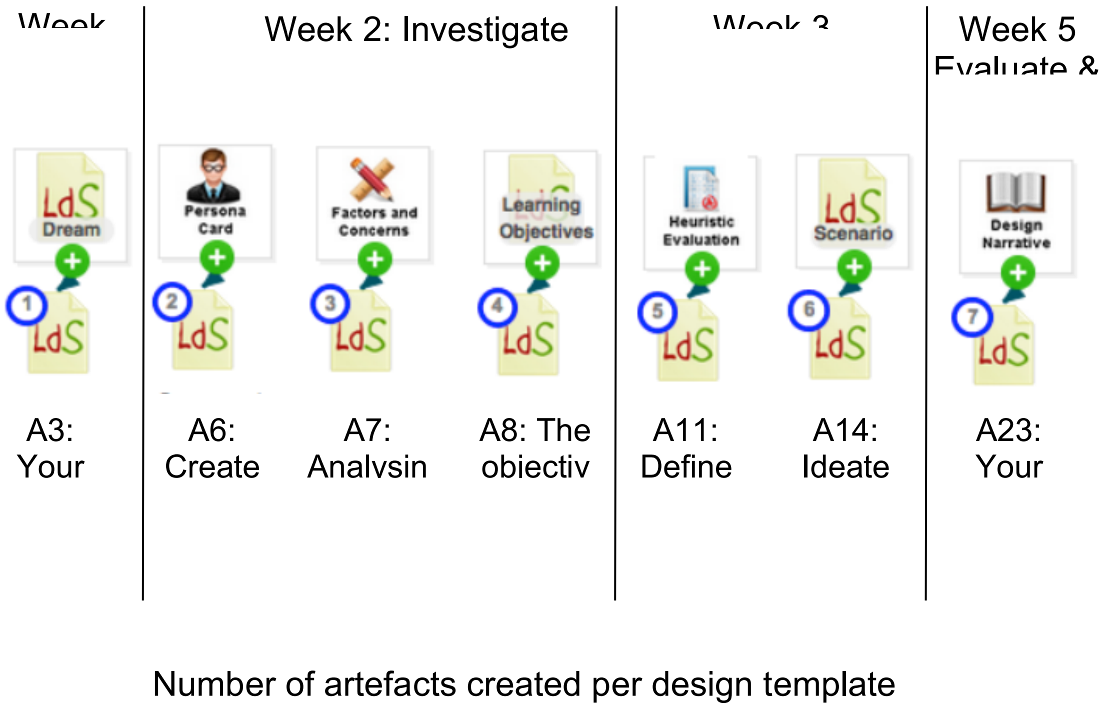

Figure 4: Details the week in which each of these design tasks took place and the amount of artefacts that were created in ILDE

As the course developed, the feedback on the activities progressively became more positive (Figure 5), with week 4 (Prototype) as the one most positively rated. However, note that the number of participants decreased as the course went on and that, most probably, only the ones that felt more comfortable with the overall approach and activities continued.

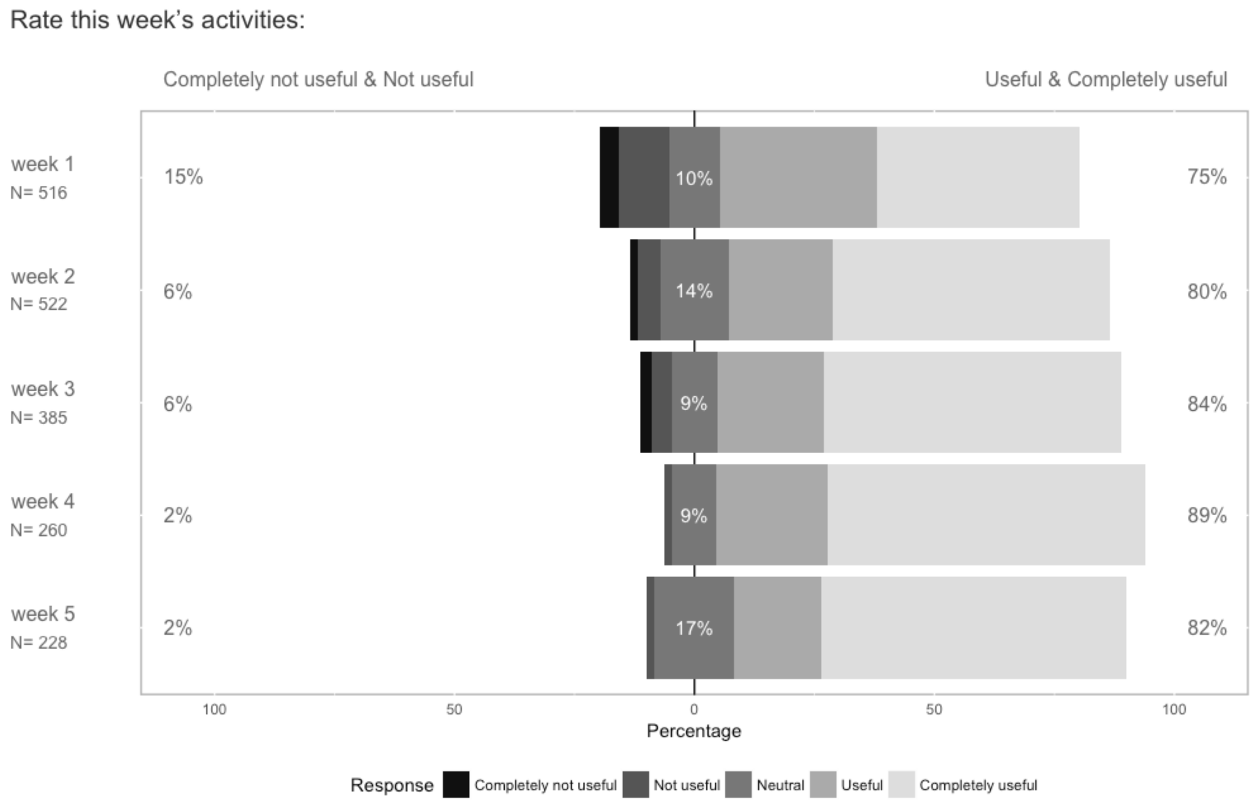

Figure 5: Aggregated ratings for each week's activities [weekly]. N corresponds to the addition of answers for all week's activities.

Looking at the ratings for each activity, in Figure 6 we see how the perception of the participants towards the design tasks fluctuated throughout the course. Both "prototype your artefact" (A16) and "revisit and update your evaluation heuristics" (A17) were the most valued of the course. They were followed by "test your prototype" (A18), "consolidate your prototype" (A19), and "peer-mentoring: consolidate your prototype" (A20). At the same level is a week 2 activity: "get familiar with the persona concept" (A5).

Week 1 features the activities with more negative ratings. The least valued was "peer-mentoring: your dream" (A4), which was hindered by technical issues and the different paces at which participants completed their activities. Again, in week 3, we see two more activities with very low scores: "define the heuristics for your design project" (A11) and "search for existing ICT-based learning activities" (A12). The latter, however, also got very high scores.

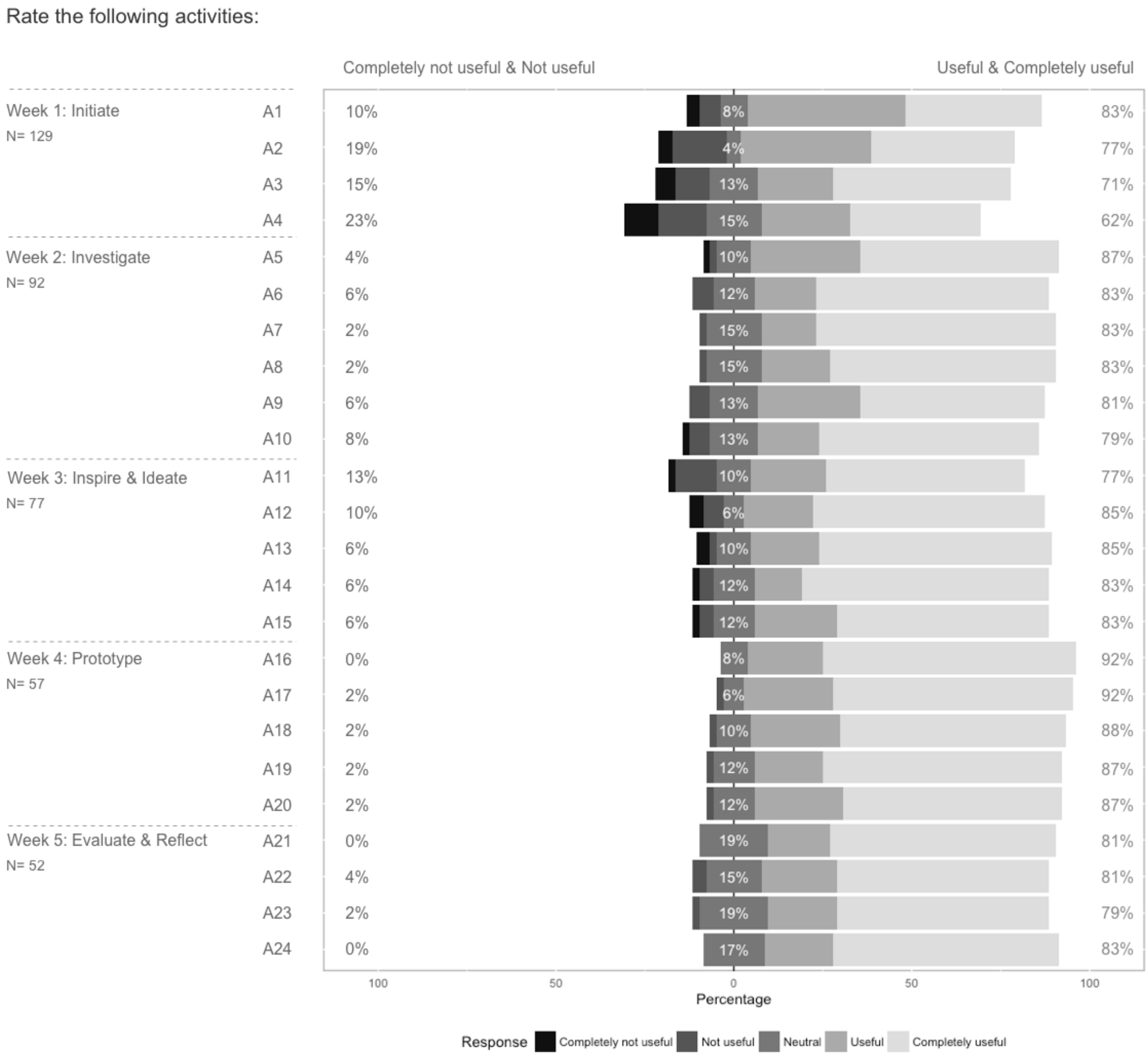

Figure 6: Participants' ratings to each design task of the MOOC

Despite this fluctuation, the overall feedback on the epistemic design of the course was positive (Figure 7). Most participants reported to plan to reuse some of the techniques learned during the course. However, they considered the course's pace too slow.

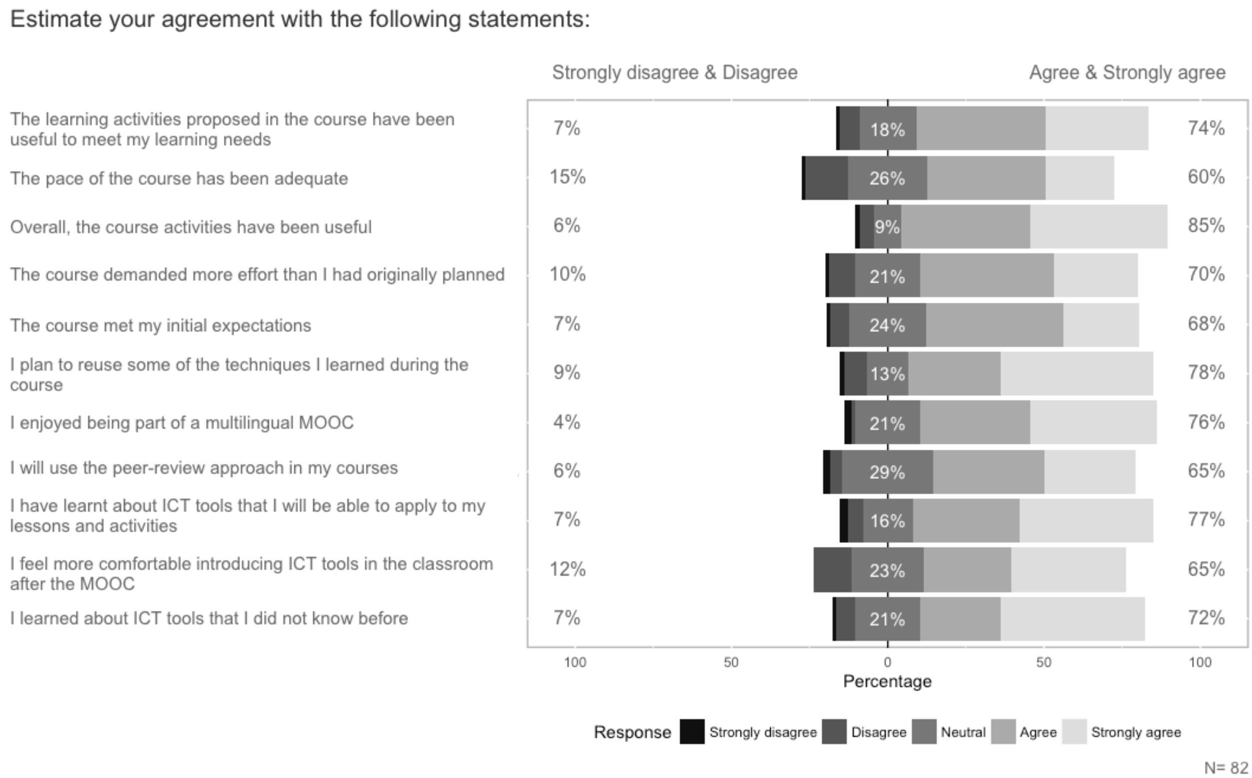

Figure 7: Participants' responses to epistemic design statements [postMOOC].

Looking more closely at the personas method, 66% of the respondents said that they would "probably" or "definitely" use the personas concept again; 27% said "maybe" and 7% ticked off "probably" or "definitely not" [weekly]. 48 of the 92 respondents also left comments. From these, 16 assimilated the concept of "persona" with an individual student; 3 considered that this is something that they were already doing; and 3 included a clear indications on how to apply this method again.

Topic 3: Use of HCD in individual experiences

Topic 3 of our research focuses on proper use of HCD. We analysed the artefacts and evidences created by six participants from the Catalan group. Through these six experiences, we understand how each one of them resolved the design tasks and later implemented the ICT-based designed learning activity in their classrooms.

Jordi: A user-centred sensibility without embracing the HCD techniques

Jordi expected to learn about new ICT tools for teaching and learning and how to design ICT-based learning activities. The Personal Education points (PE points) the MOOC provided were also key for him. He considered himself neither a novice nor an expert in LDS but expressed an interest in the approach:

> "I find it essential for any educator to design the learning experience, from scratch, thinking in the types of students we each have, and up until the evaluation of the activity, while also introducing ICT tools. It is a skill that we all have to work on, sooner or later."

This user-centred perspective reappeared in the iteration of his educational challenge, further reflecting:

> "Here is my revised dream with the new modifications! You can really appreciate the new perspective from which I look at the activity after having defined the students, their context and the learning objectives."

Jordi had trouble with the definition of the heuristics. He mistook the heuristic evaluation for an assessment guide of the activity (for before, during and after the implementation). Instead of heuristics, he listed the students' tasks.

By the end of the course, he felt he had increased his experience with and confidence in ICT tools. To him LDS was a valuable resource to include ICT in education and he would reuse this methodology; however, he would not reuse the techniques learned during the course. His biggest takeaway were the PE points.

Anna: A focus on ICT tools and theoretical pedagogical background

Anna's reported main goal was to improve her knowledge of new technologies for teaching and learning. She was also pursuing a masters' degree in Education and Technology, and she had studied some techno-pedagogical models, including Learning Design. However, she considered herself a novice in the field. She found LDS useful for her everyday work as the school she worked at had implemented a project-based methodology.

She did not review her artefacts. Her Design Studio Report is extensive, detailed, and in English (while all her other artefacts are in Catalan). This suggests she used a previously designed learning activity for her tasks in the course.

Her biggest takeaways were learning about new tools and having been part of a multilingual MOOC. She agreed with the statement "overall, the course activities have been useful". However, she said not to plan to reuse some of the techniques learned during the course.

Maria: An educational challenge focused on finding the right tool and real heuristics

Maria joined the MOOC to improve her knowledge of technologies for teaching and learning, and to learn about LDS. A key factor was also the possibility to obtain PE points.

She reported to be a novice in LDS but the concept sounded familiar to her:

> "It's the first time I see these two words together [Learning Design] but after having read the introduction, I guess that more than once I've worked with this perspective. And I do really think that it can help us change things. […] That there is a design of activities thought by an educator X for a group of students Y is a fundamental premise to make teaching and learning processes work. We have to move from reproducing to producing."

Her educational challenge was to find the right ICT tool for her goal. This emphasis on the tool instead of the learning activity was also visible in her heuristics artefact. Her list of heuristics came very close to the most common sets of rules of thumbs.

At the end of the course, she reflects:

> "Regarding this design phase, it has been a long but fascinating path during which I've had to take many decisions starting from a very specific context, which has turned out to be very clarifying. [...] The role of the designer is clear, even more when the education you want to offer respects the context in which it happens."

Sergi: An iterative and open-to-feedback approach

The HANDSON MOOC was Sergi's first one. The opportunity to obtain PE points was a key driver. Other reasons for joining were: "to improve my knowledge of new technologies for teaching and learning", "to learn about specific creativity techniques", and "to be part of an international community of educators". At the end, this last reason was the one he thinks the MOOC had been most useful for:

> "I am looking forward to see the dreams of my colleagues and be able to comment them with them… I think that their comments will be very enriching for my professional practice."

He revised his design templates several times. He did four iterations on his DreamBazaar and moved from an educational challenge in mind to the definition of a solution progressively. His work on the heuristic evaluation task was also accomplished iteratively. However, he did not define a set of rules of thumb but an evaluation rubric.

He planned to dedicate four hours/week on the MOOC and reported to have used eight. Although the course demanded more effort than he had originally planned, he was very positive about the experience and reported to plan to reuse some of the techniques he learned during the course.

Bruna: Learning Design as the ICT tools to design the activities

Bruna had joined and completed four MOOCs prior to the HANDSON one; the PE points were a very important reason for her joining. She reported to be neither a novice nor an expert in Learning Design. Her design challenge focussed on the tools she used for the design of the learning activities:

> "'Learning Design' is similar to what I do in the sense that I prepare all materials to run the classes. What seems more interesting is the idea to use the correct tools to design the learning and reach, through a special or creative way, the "user", who, in this case, are students."

Bruna described the role of the evaluator in the heuristic evaluation task as an observer of students working on the activity. The heuristics were the list of tasks that students had to accomplish. She turned the scoring sheet of the heuristic evaluation template into an evaluation rubric to use by the students while their peers are presenting their activities.

Alba: A personal recount of user-centredness and technology sensibility

Alba provided a more reflective and personal account of her experience during and after the MOOC. Despite her interest in the PE points and her ignorance of LD, she consistently showed her student-centredness.

Her main need as a teacher was to increase her knowledge of technologies for teaching and learning as she wanted to design ICT-based activities adapted to her students characteristics. In her view, educators need to analyse each student group differently, empathise with them and provide solutions to each individual. Besides this focus on the students and their needs, she wrote,

> "There is the pervasive presence of technology which can not be forgotten and needs to enter also the schools; even more when these tools are attractive and a source of motivation for our kids".

She reviewed her educational challenge three times and it was only in the last version that she really defined it:

> "In the beginning I did not have a clear idea of how to make use of this course and my dream was loosely defined. [...] I think that this process of redefining and rethinking is completely necessary when doing any kind of design… we need to show an open attitude to improve them [the designs]".

For her, the course activities were useful and she reported to plan to reuse some of the techniques she learned during the course.

> "Now that I have finished the course, I have to say that looking backwards I have learned much more than what I expected. It is clear now this new way of designing and doing. Relevant concepts such as rethinking the contextualisation through the personas technique and the peer-review approaches have been very interesting to me. Regarding the ICT tools, the course has shown the need to use them in the classroom."

An analysis across the individual experiences

Sergi and Alba and, to a lesser extent Jordi, were the participants that got most value from the MOOC and the implementation of the designed activity. These three teachers had less prior knowledge in educational methodologies and pedagogy. Sergi and Alba had also less teaching experience. The three started with an ill-defined educational challenge and iteratively concretised it through the different design activities.

In contrast, Anna, Maria and Bruna had more formal training in education and technology and also more teaching experience. These teachers started the MOOC with a high focus on the ICT tool as opposed to the HCD underpinnings of the learning activity. Their concern was not how to solve an educational challenge but how to find the right tool to implement the activity they had in mind.

Discussion & Implications for Learning Design

The HANDSON MOOC guided participants through the design of an ICT-based learning activity of their own making. Set up in the form of a learning design studio, the course aimed to provide educators the experience of a HCD cycle and a subset of its methods. We discuss next the key learnings related to our three topics.

Topic 1. How did educators perceive a learning design process conceptualised as a HCD process?

In the educators' opinion, prototyping was the most satisfactory week; it let them work directly on the design of their learning activity. This feeling of satisfaction ties in with the course's slow pace that some educators complained about. The ability to directly and 'finally' work on a solution may well explain the week's popularity. So the educators singled out one step only out of an entire HCD cycle. They apparently fully missed the other steps and HCD's cyclic nature.

We surmise that the course's pedagogical design did not provide enough context for how and why HCD is a relevant framework. Our focus on a practice-oriented approach - albeit aligned with what is known of educators as designers - should perhaps have included more onboarding to HCD. This could be done, for example, by prompting participants to think of good and bad designs; by asking them to suggest the steps involved in a good design process; or by showcasing the design process of well-known and well-designed products or services. After all examples are an important strategy to facilitate both teacher knowledge and belief change (Ertmer & Ottenbreit-Leftwich, 2010).

Topic 2. How did educators perceive HCD-based design tasks?

Results show how the MOOC yielded a positive experience for all participants, one that in their view deserved to be repeated and recommended to their colleagues. Participating educators proved to have no trouble accomplishing the course design tasks. This was the case even if their perceptions of these tasks varied, presumably depending on how closely they could align them with their own realities. This is very well exemplified by the way they dealt with the "proto-personas" and the "heuristics" activities, both very common in HCD practice.

Participants were positive towards the two personas activities. However, they just seemed to have interpreted it as a description of one of their students as opposed to creating an archetypical student to represent a bigger group, as is the concept's intended use. In contrast, participants did see the heuristic evaluation task as challenging (see also Garreta-Doming, Hernández-Leo & Sloep, 2018), probably since it was hard for them to relate it to something they already knew. Note however how the qualitative analysis on the Catalan educators reveals a similar "assimilation" pattern: instead of defining a set of heuristics some developed an evaluation form via a rubric.

Topic 3. To what extent do educators make proper use of the HCD methods and process?

The analysis of the six individual experiences shows conflicting results regarding proper usage. On the one hand, participants with less formal training in education frameworks got the most out of the MOOC. These less "knowledgeable" educators understood both the design process and how each design task fitted in it. They started with an educational challenge and iteratively defined a learning activity to address this challenge. On the other hand, participants with more knowledge of pedagogical approaches had a stronger focus on ICT tools, seemed to be biased by their earlier experiences and knowledge, and benefitted less of the HCD approach and techniques.

We can interpret these last findings in the light of how teachers' beliefs either hinder or facilitate technology use (Tondeur et al., 2017). Beliefs influence knowledge acquisition, interpretation of course content, and comprehension monitoring (Pajares, 1992). As a result, previous knowledge and experiences seem to have prevented our more pedagogically knowledgeable participants from adopting a HCD mindset. On the other hand, "less knowledgeable" participants followed and benefited from the guidance provided in the course. Both Pajares (1992) and Wright (1997) discuss the pervasiveness of educational beliefs of preservice teachers; this notwithstanding, our results lend support to the inclusion of HCD in teacher training as early as possible, that is before prejudice or ill-founded beliefs have gotten hold of student-teachers.

Our central research hypothesis that HCD practice is directly transferable to the design practices of educators we consider confirmed by our findings That is, we reaffirm that the practice-oriented, hands-on and empirical approach of HCD can help creating the necessary experiences to (re)shape educators' beliefs. It can occupy the "middle ground territory" between philosophy and pedagogical tactics (Goodyear, 2005) which is often complex and demanding in terms of design. Nevertheless, HCD practice needs to be contextually tweaked prior to its transfer.

We also conclude that educators should be repeatedly and iteratively exposed to HCD. Pedagogical beliefs tend to be persistent and formed by past experiences, thus, long-term (and embedded) professional development is needed in order to change teachers' pedagogical beliefs and practices (Tondeur et al., 2017). The willingness of the participants to repeat and recommend our one instance should be leveraged by researchers, practitioners or institutions willing to put in place HCD for the design of learning activities.

It is also our belief that HCD can contribute to tackle the other two considerations that impact educators' design for learning: teachers' perceptions on students and contextual factors. HCD is very much aligned with student-centered beliefs; which have been reportedly matched to higher and better technology use. With Ertmer and Ottenbreit-Leftwich (2010), we think that one of the best ways to support teacher change is by providing opportunities for them to witness how the change benefits their students. The iterative nature of HCD integrates this monitoring and assessment.

Our study is focussed on the micro-level, with educators as change agents. However, HCD also has the power to affect their context as it could improve the entire activity system - as Carvalho and Goodyear (2017, p. 17) call it. HCD is applied in the development of much digital technology - and increasingly services. A shared mindset, set of methods and process facilitates collaboration and is likely to impact the meso and macro levels.

As a concluding remark, we recall Schön's point about 'reflection on (and in) action' (1983). The enhanced reflection that HCD mindset, methods and process bring, can provide 'educators as designers' with a more rational perspective on the design process.

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Statements of open data, ethics and conflict of interest

The datasets used to underpin this paper (survey results, individual case description and data) are available in Zenodo as open data (https://doi.org/10.5281/zenodo.1181955).

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The authors have no conflicts of interest to report.

References

Asensio-Pérez, J. I., Dimitriadis, Y., Pozzi, F., Hernández-Leo, D., Prieto, L. P., Persico, D., & Villagrá-Sobrino, S. L. (2017). Towards teaching as design: Exploring the interplay between full-lifecycle learning design tooling and Teacher Professional Development. *Computers and Education*, *114*, 92–116. http://doi.org/10.1016/j.compedu.2017.06.011

Beetham, H., & Sharpe, R. (2013). *Rethinking Pedagogy for a Digital Age: Designing for 21st Century Learning*. *Rethinking Pedagogy for a Digital Age* (2nd ed.). London: Routledge. http://doi.org/10.1111/j.1467-8527.2008.00397_1.x

Beijaard, D., & Vries, Y. De. (1997). Building Expertise: a process perspective on the development or change of teachers' beliefs. *European Journal of Teacher Education*, *20*(3), 243–255. http://doi.org/10.1080/0261976970200304

Bennett, S., Agostinho, S., & Lockyer, L. (2016). The process of designing for learning: understanding teachers' design work. *Educational Technology Research and Development*, *65*(1), 125–145. http://doi.org/10.1007/s11423-016-9469-y

Carvalho, L., & Goodyear, P. (2017). Design, learning networks and service innovation. *Design Studies*, 1–27. http://doi.org/10.1016/j.destud.2017.09.003

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). Los Angeles: SAGE Publications, Inc.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*(3), 255–284. http://doi.org/10.1080/15391523.2010.10782551

Garreta-Domingo, M., Hernández-Leo, D., & Sloep, P. B. (2018). Evaluation to support learning design: Lessons learned in a teacher training MOOC. *Australasian Journal of Educational Technology*, *33*(1). http://doi.org/https://ajet.org.au/index.php/AJET/article/view/3768

Goodyear, P. (2015). Teaching as design. *HERDSA Review of Higher Education*, *2*, 27–50. Retrieved from http://www.herdsa.org.au/wp-content/uploads/HERDSARHE2015v02p27.pdf

Goodyear, P. (2005). Educational design and networked learning: patterns, pattern languages and design practice. *Australian Journal of Educational Technology*, *21*(1), 82–101. Retrieved from http://ascilite.org.au/ajet/submission/index.php/AJET/article/view/1344/714

Goodyear, P., & Carvalho, L. (2014). Framing the analysis of learning network architectures. In *The Architecture of Productive Learning Networks* (pp. 48–70).

Hernández-Leo, D., Asensio-Pérez, J. I., Derntl, M., Prieto, L. P., & Chacón, J. (2014). ILDE: community environment for conceptualizing, authoring and deploying learning activities. In *EC-TEL 2014. LNCS, vol. 8719* (pp. 490–493). Heidelberg: Springer. http://doi.org/https://doi.org/10.1007/978-3-319-11200-8_48

Laurillard, D. (2012). *Teaching as a Design Science: Building Pedagogical Patterns for Learning and Technology*. New York and London: Routledge.

Markauskaite, L., & Goodyear, P. (2009). Designing for complex ICT-based learning: Understanding teacher thinking to help improve educational design. In *Same places, different spaces. Proceedings ascilite Auckland 2009* (pp. 614–624). Auckland: Proceedings ascilite Auckland 2009. Retrieved from http://www.ascilite.org/conferences/auckland09/procs/markauskaite.pdf

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054. http://doi.org/10.1111/j.1467-9620.2006.00684.x

Mor, Y., Craft, B., & Hernández-Leo, D. (2013). The art and science of learning design (editorial). *Research in Learning Technology*, *21*(22513), 1–8. http://doi.org/http://dx.doi.org/10.3402/rlt.v2li0.22513

Mor, Y., & Mogilevsky, O. (2013). The learning design studio: collaborative design inquiry as teachers' professional development. *Research in Learning Technology*, *21*(1), 1–15. http://doi.org/https://doi.org/10.3402/rlt.v21i0.22054

Norman, D. A. (2013). *The Design of Everyday Things: Revised and Expanded Edition*. Basic Books.

OECD. (2015). *Students, Computers and Learning: Making the Connection*. Paris. Retrieved from http://www.oecd-ilibrary.org/education/students-computers-and-learning_9789264239555-en

Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information Systems Research*, *2*(1), 1–28. http://doi.org/10.1287/isre.2.1.1

Pajares, M. F. (1992). Teachers' beliefs and educational research: cleaning up a messy construct. *Review of Educational Research*, *62*(3), 307–332.

Reimer, Y. J., & Douglas, S. A. (2003). Teaching HCI Design With the Studio Approach. *Computer Science Education*, *13*(3), 191–205. http://doi.org/10.1076/csed.13.3.191.14945

Schön, D. A. (1983). *The Reflective Practitioner; How Professionals Think in Action*. USA: Basic Books.

Simon, H. A. (1996). *The Sciences of the Artificial* (3rd ed.). Cambridge, MA: MIT Press.

Sloep, P. B. (2013). Networked professional learning. In A. Littlejohn & A. Margaryan (Eds.), *Technology-enhanced Professional Learning: Processes, Practices and Tools* (pp. 97–108). London: Routledge. Retrieved from http://hdl.handle.net/1820/5215

Tondeur, J., van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence. *Educational Technology Research and Development*, *65*(3), 555–575. http://doi.org/10.1007/s11423-016-9481-2

Winograd, T. (1990). What Can We Teach About Human-Computer Interaction. In *CHI'90 Proceedings* (pp. 443–449). New York, NY. http://doi.org/10.1145/97243.97322

Wright, M. Von. (1997). Student Teachers' Beliefs and a Changing Teacher Role. *European Journal of Teacher Education*, *20*(3), 257–266. http://doi.org/10.1080/0261976970200305

Garreta-Domingo, M., Hernández-Leo, D., & Sloep, P. B. (2018). Evaluation to support learning design: Lessons learned in a teacher training MOOC. *Australasian Journal of Educational Technology*, *33*(1). http://doi.org/https://ajet.org.au/index.php/AJET/article/view/3768

Evaluation to support learning design: Lessons learned in a teacher training MOOC

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Designing learning opportunities is an integral part of the work of all educators. However, educators often lack the design skills and knowledge that professional designers have. We thus need more empirical research on the "demand side": how do educators design technology-enhanced learning activities, and how do we provide them with actionable knowledge that helps them design from a (human-centred) design perspective? The present study addresses both questions by analysing how in-service educators perceived and accomplished an (heuristic) evaluation design task as part of a design process to conceptualise a learning activity using information and communication technologies (ICT). Following a mixed-methods approach, we collected the heuristic evaluation protocols produced by the participants and their comments. The data shows that educators failed to perceive the task as actionable knowledge. To remedy this, we propose a set of design tasks that would provide the needed scaffolding to include the concept of design principles as part of educators' learning design processes; empowering them to assess both existing learning activities and ICT tools as well as their own designs.

Introduction

Educators are commonly seen as designers of learning opportunities (Bennett, Agostinho, & Lockyer, 2016). They must perceive, interpret and act upon existing resources as well as devise new ones when needed; they must evaluate constraints such as those imposed by the classroom setting, balance trade-offs such as between effectiveness and efficiency, and devise strategies to pursue their specific instructional goals (Brown & Edelson, 2003). In design parlance, educators try out, adapt and create resources to solve an educational design challenge.

However, educators often struggle to think like designers (Bencze & Hodson, 1999; Penuel & Gallagher, 2009). Rather, they tend to see themselves as bearers and conduits of knowledge, skills and values (Garreta-Domingo, Sloep, Hernández-Leo, & Mor, 2017b), focusing on the design of content almost in a vacuum. According to Goodyear (2015), "a teacher who doesn't have a sense of design as a process, and who doesn't have the conceptual tools and skills to work through a design problem in a creative but structured way, will be likely to jump straight to a solution." (p. 31).

This rush for implementation also involves a lack of process monitoring (Boschman et al., 2014); educators do not attend much to the analysis of the success or failure of the learning activities they implement. As a result, evaluation, together with problem analysis, are the two stages most often overlooked by educators (Hoogveld, Paas, Jochems, & Van Merriënboer, 2002).

The major aim of the field of learning design is to empower educators as designers. It does so by understanding how the intuitive processes undertaken by teachers and trainers can be made visible, shared, exposed to scrutiny and, consequently, made more effective and efficient as well as fit to incorporate information and communication tools (Laurillard, 2012; Mor, Ferguson, Wasson, 2015). However, and in spite of more than a decade of research (Dalziel et al., 2016), learning design has not widely impacted teaching practice (Bennett et al., 2016). Some argue that too much focus has been put on the "supply side" (tools, standards, software and infrastructure), too little on the "demand side" (Asensio-Pérez et al., 2017; Kali, Goodyear, & Markauskaite, 2011). To better understand teachers' actual design practices – the demand side – more empirical research is needed. This should result in a closer alignment between teachers' needs and learning design initiatives (Agostinho, Bennett, Lockyer, & Harper, 2011). As McKenney, Kali, Markauskaite, and Voogt (2015, p. 181) point out, “to date, little has been done to capitalize on what is already understood about teachers as designers nor to draw on the wealth of literature on designers and designing outside the field of education”.

The research reported here conceptualises and analyses a design task for educators that is enacted in an authentic teacher training setting. It borrows from an existing and widely used concept and method in human-centred design and directly applies it in an educator’s design process. This is aligned with the “steadily growing awareness within education that the established design professions have some methods for dealing with very complex issues, resolving conflicting requirements, reframing problems, and working with ‘end users’ (customers and clients; students) that are useful in educational practice” (Goodyear, 2015, p. 28). Thus, empowering educators with the methods and processes of human-centred design is a promising path towards addressing the challenges that the learning design field has. The question that remains is how to guarantee impact and efficiency through actionable knowledge that can support educators’ tasks. We address this issue in a specific design step: evaluation prior to enactment.

The specific human-centred design method we selected is *heuristic evaluation* (HE), a usability inspection technique that does not involve users’ quizzing. It is a method widely used in software development and is among the easiest to learn (Nielsen & Mack, 1994; Ssemugabi & de Villiers, 2010); it is also efficient, and time- and cost-effective (Albion, 1999). Nielsen et al. (1994) describe it as discount usability engineering. HE thus seems like a natural fit in the current design practices of educators: which is above all practice-driven and practice-oriented (Boschman, McKenney, & Voogt, 2014; Doyle & Ponder, 1977; Ertmer, 1999; Janssen, Westbroek, Doyle, & van Driel, 2013; Matuk, Linn, & Eylon, 2015).

This article, then, aims to tackle the following theoretical issue: does the concept of heuristics and the method of heuristic evaluation provide actionable knowledge for design in education? We focus on the micro or user level (Kali et al., 2011) in order to explore the situated nature of design cognition. The broader objective is to have a clear idea of which kinds of design thinking teachers find easy and which difficult, and which tools – including methods upon which they draw – make the largest difference (Markauskaite & Goodyear, 2009).

Our study is framed within an interpretive research paradigm (Orlikowski & Baroudi, 1991), since it seeks to fathom the specifics and the richness of the concrete phenomena under study. We focus on the interplay between a teacher’s perception of as well as his/her reflection on a design task and the designs produced. The study is exploratory, focuses on one particular authentic teacher-training context, and relies mainly on qualitative evidence (Asensio-Pérez et al., 2017). In the present study our specific research question is contextualised as follows: How does a design task based on the HE method perform in a realistic teacher training setting? This contextualisation will influence the interpretation of the data (Stake, 2010, Chapter 2.5). Our research question encompasses two topics: *How do participants accomplish their design task?* (Topic 1) and *How does their design thinking unfold?* (Topic 2). These two topics call for the collection and analysis of different types of data: the steps participants take to carry out the design task, the outcomes that participants construct as well as the comments and reflections on the task that they produce. Lessons learned through the exploration of these questions will inform the formulation of tasks along enhanced learning design processes.

In summary, we want to (1) extend and enhance the existing pool of empirical research on how to build on teacher expertise to support them in their design efforts; (2) examine the use of human-centred design methods to empower the designers’ capacity of educators; and (3) inform both practice and research in the fields of learning design. Thus, the specific interest of our study lies in the insights it provides for both researchers and practitioners in the field of learning design and teacher training. The findings from this study can be relevant to researchers trying to understand how educators design but also to practitioners who are currently designing frameworks, activities and tools to enhance educators’ design skills.

Methodology

Context: the HANDSON MOOC

The context of our study is a massive open online course (MOOC) that was intended to offer a professional development opportunity for educators of all educational levels (Garreta-Domingo, Sloep, Hernández-Leo, & Mor, 2017a). The HANDSON MOOC – implemented under a Lifelong Learning Programme project (http://www.handsonict.eu/) – was open and free. It was disseminated through the project blog, and each project partner used their networks to reach out to as many educators as possible. Following the terms used in Goodyear and Carvalho's (2014) activity-centred analysis and design (ACAD) model, the MOOC has a set, social and epistemic design dimension.

The set design of the MOOC included Moodle as the course platform and the Integrated Learning Design Environment (ILDE) as the design platform. ILDE is a web platform that helps communities of educational designers to co-create and share learning designs both from scratch or by using the templates provided (Hernández-Leo, Asensio-Pérez, Derntl, Prieto, & Chacón, 2014). The syllabus and instructions for the course activities as well as the discussion forums – the main asynchronous communication tool used – were held in Moodle. The social design comprised peer-to-peer interaction. Four facilitators kicked off the course and guided the theoretical discussions and convergence sessions. However, participants were prompted to learn from each other by commenting on their peers' artefacts. The epistemic design was based on the Learning Design Studio (LDS), which rests on human-centred design principles (Mor & Mogilevsky, 2013). In LDS, participating teachers engage in a design project that addresses a specific educational challenge; and facilitators – in the HANDSON MOOC, peers too – provide continuous guidance throughout the design process. Thus, participants were walked through the design of an ICT-based learning activity, that by the end of the course was supposed to be ready for enactment in their respective teaching settings. This was accomplished by completing 25 design tasks in ILDE (Figure 1). Besides carrying out these specific tasks, educators were prompted to keep a learning journal in which they could write their personal reflections on the course and the design process. In line with our research question, the focus of the present paper is on the heuristics activity (Week 3, Activity 13 in particular).

A total of 743 teachers voluntarily enrolled, and 68 educators completed the MOOC obtaining the "Designer Badge" as token of their accomplishment. The socio-demographic data of the participants was gathered through a pre-course survey, filled out by 374 educators. Of the respondents, 72% were female, 26% were male, and 2% replied N/A. Of the participants, 50% indicated they had a master's degree. The rest were distributed as follows: bachelor (24%), initial teacher education (13%), PhD (7%), N/A (6%). Participants were mostly involved in secondary (50%) or primary education (28%). The percentage for higher education was 19%, followed by teacher training (12%), adult education (9%), vocational education (5%) and other (4%). Most participants were from Greece (73%) and Spain (6%). English was the language used in the MOOC.

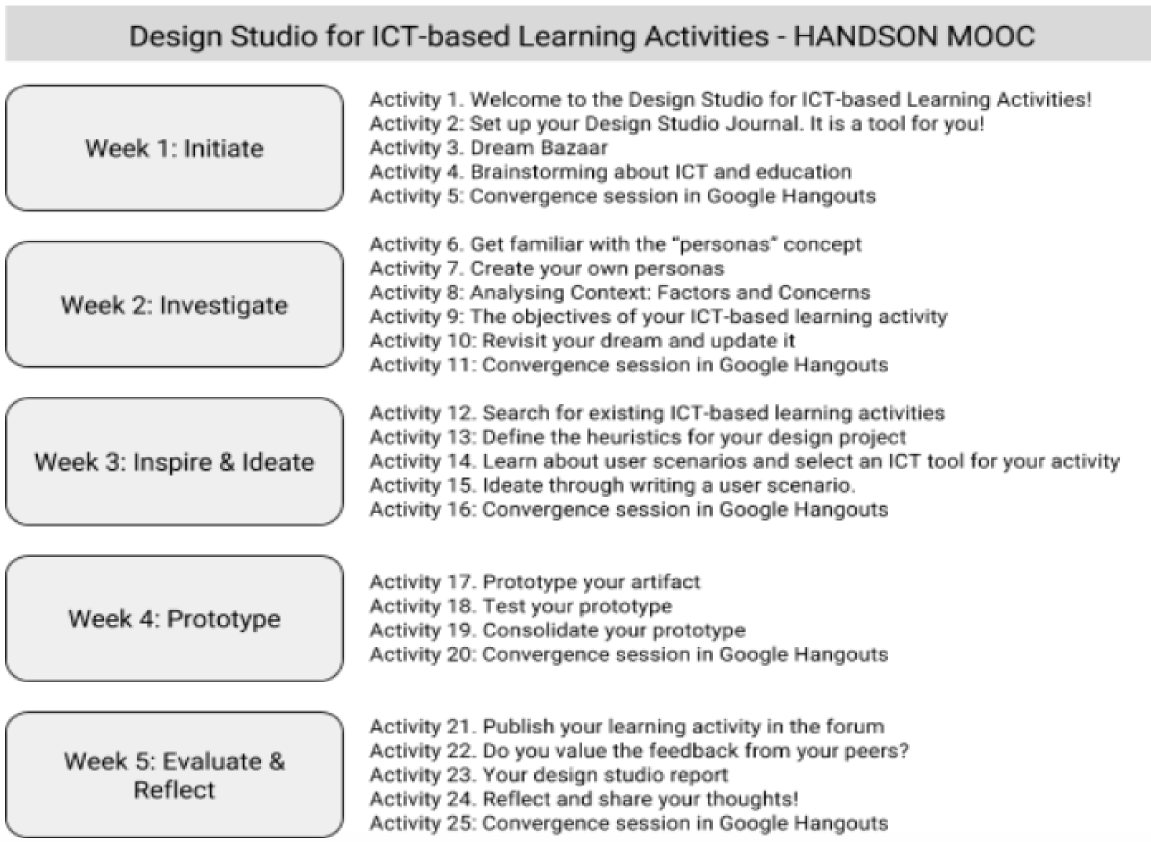


Figure 1. The HANDSON MOOC's learning tasks

Procedures: the design task

By Week 3, each participant had defined and refined a design challenge, created a persona card, thought about the contexts of their students, and defined the goals for their ICT-based learning activity. The instructions for the HE activity (Figure 2) focused on assessing the relevance of evaluating as early as possible in the design process; participants were invited to create their own heuristics based on the outcomes of the tasks completed by them previously, as part of their participation in the MOOC (see Figure 1).

The HE protocol template available from ILDE (Figure 3) guided participants through the details of the task. Participants were not only prompted to create their own heuristics, but they were also guided to check existing heuristics and select those adequate for their own design project.

The two different approaches to define a heuristic evaluation protocol match the two usages of heuristics in education, the most common one being to assess technology-enhanced learning tools (Reeves et al., 2002; Ssemugabi & De Villiers, 2007, 2010). In this case, it is common to start from existing sets of heuristics and adapt them as needed. The second usage has been less explored. It sees heuristics as principles and processes that can help educators to skilfully structure their work (McKenney et al., 2015; Janssen et al., 2013). These design heuristics become, in our context, tools to increase the efficiency and effectiveness of teachers' design work. With this aim, it is more adequate to define ad hoc design principles rather than just using an existing set. Given our research question, we decided to be approach-agnostic. This allowed us to observe the phenomena in a more natural way as well as better understand how the existing knowledge of educators can be leveraged by human-centred design methods.

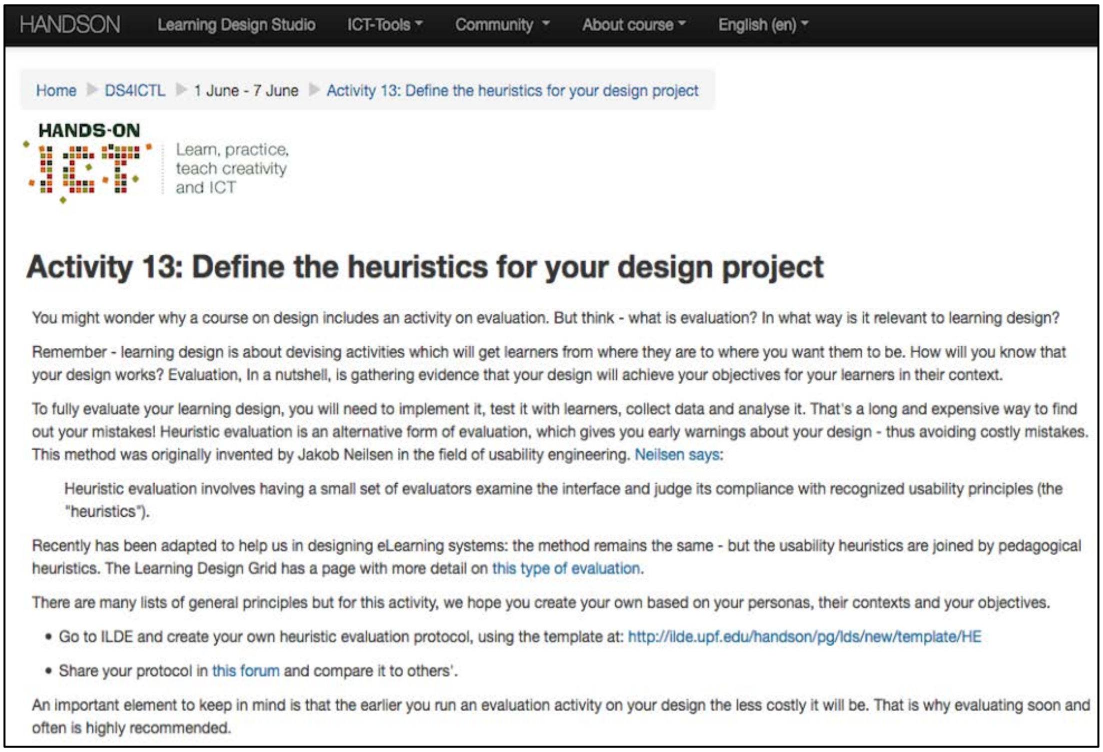


Figure 2. Screenshot from the Moodle environment

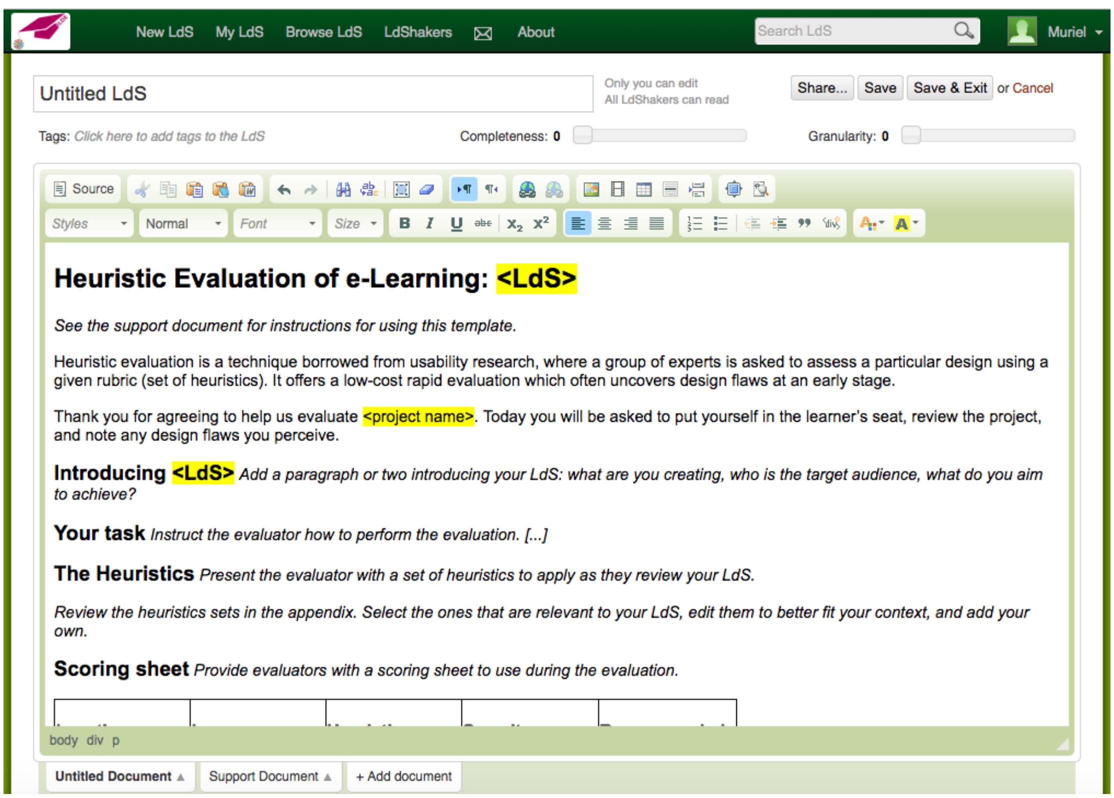


Figure 3. Heuristic evaluation template in ILDE. See https://ilde.upf.edu/handson/v/kuf for the complete template.

Both in Moodle and ILDE, HE-supporting learning materials were available, including videos about heuristic evaluation as applied in software development and links to education-related resources. Participants had access to four sets of existing heuristics (Mor et al., 2011). Table 1 describes these sets and includes an example of an overlapping heuristic. The heuristics provided combine usability and educational heuristics.

Table 1
How typical examples of design heuristics relate to the four sets of heuristics provided to the participants

Set name	Set description	Example of a usability/user interface heuristic	Example of an educational design heuristic
User interface heuristics by Albion (1999)	A combined set of 28 heuristics organised in three categories: interface design heuristics (after Nielsen & Mack, 1994), educational design heuristics (after Quinn, 1996) and content heuristics. Each heuristic has a statement followed by a short description.	*Maximises match between the system and the real world.* The design speaks the users' language rather than jargon. Information appears in a natural and logical order.	*Clear goals and objectives.* The software makes it clear to the learner what is to be accomplished and what will be gained from its use.
User interface heuristics by Beale & Sharples (2002)	A usability set of nine heuristics defined with a brief title and a statement.	*Everyday language***.** Use simple language, avoid technical terms, follow real-world conventions to make things appear logical.	N/A
Learning design heuristics by Ssemugabi & de Villiers (2010)	An educational set of 20 heuristics organised in three categories: • General interface usability criteria (based on Nielsen & Mack's (1994) heuristics, modified for e-learning context) • Website-specific criteria • Educational criteria: Learner-centred instructional design, grounded in learning theory. Each heuristic has a short statement and a small set of related statements.	*Category 1: General interface usability criteria (based on Nielsen & Macks's (1994) heuristics, modified for e-learning context)* *Match between the system and the real world,* i.e., match between designer model and user model • Language usage in terms of phrases, symbols, and concepts is similar to that of users in their day-to-day environment. • Metaphor usage corresponds to real-world objects/concepts. • Information is arranged in a natural and logical order.	*Category 3: Educational criteria: Learner-centred instructional design, grounded in learning theory* *Clarity of goals, objectives and outcomes* • There are clear goals, objectives and outcomes for learning encounters. • The reason for inclusion of each page or document on the site is clear.

Educational design heuristics by Benson et al. (2001)	A set of 20 educational heuristics defined with a short title, a statement and three sample questions to ask regarding the heuristic.	*Match between system and the real world.* The e-learning program interface employs words, phrases and concepts familiar to the learner, rather than system-oriented terms. Wherever possible, it utilises real-world conventions that make information appear in a natural and logical order. Sample questions to ask yourself: • Does the navigation and interactive design utilise metaphors that are familiar to the learner either in terms of traditional learning environments (e.g., lectures, quizzes, etc.) or in terms related to the specific content of the program? • Is the cognitive load of the interface as low as possible to enable learners to engage with the content, tasks … as quickly as possible?	*Learning design.* The interactions in the e-learning program have been designed in accord with sound principles of learning theory. Sample questions to ask yourself: • Does the e-learning program provide for instructional interactions that reflect sound learning theory? • Does the e-learning program engage learners in tasks that are closely aligned with the learning goals and objectives? • Does the e-learning program inform learners of the objectives of the program and remind them of prior learning?

Participants

A total of 81 participants submitted their heuristic evaluation protocol in the discussion forum. From these, only 36 participants were kept as they provided meaningful comments on the activity in the forum or wrote a learning journal entry (either source of data is useful). The 45 protocols left out were analysed to ensure that the 36 participants selected were not atypical cases. All 81 participants proved to produce similar protocols.

Participants were coded with a number, from P1 to P36. This number corresponds to the ranking order in which participants shared their heuristic protocol to the forum: P1 denotes the first one to share, P36 the last. The participant number is relevant to inform our topics of study, as we focus not only on the artefacts produced (Topic 1) but also on how the participants' design thinking unfolded during and after task completion (Topic 2).

Participants were informed that their products (protocols, contributions to the forum) could be used for research purposes, including their publication. All were in accord, provided their products were anonymised.

Data collection

As mentioned in the Introduction, our study is framed within an interpretative research paradigm (Orlikowski & Baroudi, 1991). Therefore, our research design follows a concurrent, embedded, mixed-methods strategy (Creswell, 2009), relying mainly on qualitative evidence. Table 2 summarises these data sources and formats. Data is collected to inform the two topics under exploration.

Table 2
Data collected, in various formats, and topics informed

Data source	Data format	Topic(s) informed
Heuristic protocols (ILDE template)	Protocols created by the participants following the heuristic evaluation template (see Figure 2) (qualitative)	Topic 1
Discussion forum (Moodle)	Written messages on the Moodle discussion forum for activity 13 (qualitative) [DisFor]	Topics 1 and 2
Learning design journal (ILDE)	Written account of the participants reflections on their learning process (qualitative) [LearnJ]	Topics 1 and 2
Data on page views (Google Analytics)	Data based on the number of artefact views and their characteristics (quantitative)	Topic 1
Weekly survey questions (Google Forms)	The weekly surveys were sent out at the end of each week and included closed questions on the level of difficulty of the course activities (quantitative).	Topics 1 and 2

Data analysis

Given the two main data sources – artefacts produced and comments and reflections – two different data analysis strategies were applied (Table 2).

The heuristic protocols produced by the participants were analysed against the existing sets of heuristics provided. The analysis focused on finding which patterns emerged from these artefacts. We employed a two-step approach: what overall form did the protocols have and which were these heuristics? For the first step, the analysis aimed to see if the participant had used an existing set of heuristics to start with and what, if any, these were. The second step – following a semi-quantitative approach – consisted of listing all existing heuristics provided and noting which ones were included in the protocols the participants produced.

The data gathered from [DisFor] and [LearnJ] were analysed through thematic analysis (see Table 3). Here the epistemological aim is to give voice to the participants, to unravel the reality of the prospective teacher experience by identifying the patterns of meaning in their accounts (Braun & Clarke, 2006). As Braun and Clarke recommend, the entire data set was scanned various times, with the subsequent analysis involving becoming familiar with the data (responses), generating and reviewing codes, searching for themes, and reviewing themes.

Finally, the quantitative data concern responses to the questionnaires that were sent out (Table 2). The two questions we focus on are how useful and difficult the participants considered the activities of Week 3, in particular the heuristic evaluation (activity 13). Possible answers were “very useful”, “useful”, “not applicable”, “kind of useful”, “not useful” and “very simple”, “simple”, “just about right”, “difficult” and “very difficult”, respectively. Week 1 did not include the question about difficulty. Responses were grouped in three main categories. Note that the presentation of the survey responses does not differentiate between the 36 participants.

Table 3
Qualitative analysis of the data collected from the participants

Themes	Codes	Example quote	Participant
Lack of understanding of the activity	“struggle”, “difficult”, “effort”, “demanding”, “complicated”	“June 4 – I finally wrote my Heuristic Evaluation. I found this activity a little difficult. It was not so easy for me to understand the task.” [LearnJ]	P16
Uncertainty towards the produced artefacts	“I did my best”, “I’m not sure that what I did is correct”, “Did I do it in the appropriate way?”	“I have followed the instructions of our facilitators and read the protocol of my peers. Here you can see my heuristics. I am anxious about the comments. Did I do it in the appropriate way? I would appreciate your opinion.” [DisFor]	P20
Positive towards the HE method	“A very useful tool.” “It's a great idea to review learning designs before you use them.”, “I have to keep in my mind the heuristics when designing the learning activity.”	“It was very interesting to read about the heuristics, I have never heard about them and now I know how important they are and I think about situations when I did not understand something or I did not find what I want, maybe there were something wrong with the whole concept.” [LearnJ]	P35

Results

The Results section consists of three subsections. The first one focuses on how participants approached the HE design task (Topics 1 and 2). The second one covers the analysis of the artefacts that participants produced (Topic 1). The third addresses how the design thinking of participants unfolded (Topic 2).

How participants approached their task (Topics 1 and 2)

According to the epistemic and social design of the MOOC, participants used two different sources to inform their work on the evaluation task. First, they followed the heuristic task instructions by reading the provided materials. Thus, the existing sets of heuristics were a key starting point for them (more evidence on this in the next subsection). Second, they followed the social design approach of the MOOC and looked at each other’s artefacts and also commented on them. See Tables 4 and 5.

Table 4 consists of some of the participants’ explanations on how they went on with the HE design task ([LearnJ] [DisFor], Table 2). This data shows a trend in the way participants approached the design task: participants felt the need to look at examples of what they were asked to do in order to produce their own protocols. Thus, neither the set of existing heuristics provided nor the prompt to define their own heuristics were sufficiently actionable (knowledge) to allow them to accomplish their task.

Table 4
Examples of how participants expressed they had accomplished the task

Participant	Example
P28	I searched through the sets of heuristics given, and chose those that I thought were relevant to everything my learning activities are meant to be like ideally/everything they should contain. [LearnJ]
P10	Heuristic evaluation is an alternative form of evaluation. After searching and reading some articles in regards to the principles of an evaluation - The Learning Design Grid this type of evaluation and Nielsen, I came up with my evaluation protocol. [LearnJ]
P23	I saw your [PARTICIPANT'S NAME, P6] work and it is very good! I also studied your evaluation sheet and with your permission I will use it as a prototype for my evaluation sheet! Excellent work! Bravo! Thank you for the inspiration! [DisFor]
P1	You did very well, [PARTICIPANT'S NAME, P3]! [DisFor]
P3	Thank you [PARTICIPANT'S NAME, P1]. There are no words to say for you. You learn [teach, authors' insertion] me many things. You did an excellent job. [DisFor]

The quantitative data confirm the qualitative data (Table 5). In the absence of more scaffolding for this design task, educators looked for guidance in the first protocols that were shared by fellow participants. The first two artefacts publicly shared in the discussion forum were the ones that received most views: P1's design was the one most viewed by the participants.

Table 5
Influence of first movers on remaining participants

Participant	Date of publication in forum	Date of update in forum	Views	Users	Sessions	Average duration	Returning visitors
P1	Saturday, 31 May 2014, 6:09 PM - This was the first protocol shared in the forum	Tuesday, 3 June 2014, 8:54 PM	3727	102	170	0:40:53	92.4%
P2	Saturday, 31 May 2014, 10:08 PM		1802	65	85	0:40:07	94.1%
P10	Monday, 2 June 2014, 9:23 PM	Tuesday, 3 June 2014, 1:01 PM	1154	35	42	0:46:45	88.1%
P8	Monday, 2 June 2014, 10:21 AM (the link in this post did not work)	Monday, 2 June 2014, 10:21 AM (with link working)	1287	40	55	0:40:20	94.5%
P7	Monday, 2 June 2014, 8:32 PM		909	30	38	0:42:46	89.5%

What participants produced (Topic 1)

As mentioned, participants were given two apparently – but purposely – divergent indications on how to tackle their design task. At that stage in the design process, the objectively most useful output of the heuristics design task was a set of self-defined heuristics to synthesise what they had already done (design challenge, persona card, context analysis and objectives for the learning activity) so that they could use them as design principles for the next steps.

As part of our research design, participants were provided with a light form of guidance. The previous subsection showed one of the consequences thereof: participants resorted to what other participants had done to accomplish their own task. As a consequence, the fact that P1 – the participant with most page views – created a protocol by adapting an existing set had a significant impact on the way the other participants drafted their protocols.

All protocols produced by the participants were based on the sets of heuristics that were provided as part of the learning materials. In the analysis of the form that these adaptations took, three formats emerged: the artefacts that are based on one of the set of heuristics provided, the artefacts that are a combination of heuristics from different sets, and the artefacts that are question-based. This classification is relevant as it shows different degrees of processing – and probably understanding – of the task. Thus, participants that took one existing set and selected heuristics from this single set showed the largest discrepancy between their heuristics and their design, as a pre-existing set of heuristics is by default as standard and generalisable as possible. On the other hand, the protocols that were based on a set of questions differed the most from the sets provided.

Table 6 provides an overall classification of the 33 protocols (out of 36) analysed. Three artefacts are not included for further analysis; one was an exact copy of a pre-existing set, another one included only the headings of the heuristics as in the sets provided, and the third one contained no heuristics (see last line of Table 6).

Table 6
Classification of heuristic protocols according to the format type

Type of protocol	Source of inspiration	No. of protocols
Adaptation	Benson et al. (2001) heuristics	10
Adaptation	Ssemugabi & de Villiers (2010) heuristics	3
Adaptation	A combination of the different sets of heuristics provided	7
Questions	A set of questions	13
Not analysed	Not a real heuristic protocol	3

Heuristic protocols adapted from existing sets
Given the classification in Table 6, a total of 20 protocols fall into the “adapted from existing sets” category. Their authors chose to adapt an existing set of heuristics; they did so by maintaining the title of the heuristic and making variations in the sample questions for each heuristic. Figure 4 shows an example of this (protocol of P1).

My Heuristics Evaluation Protocol for my Learning Design.

1. Visibility of learning design (LD) status:

- Is the learner guided in every step in detail, where to go and how to act?
- Are instructions rendered with clarity and precision?
- Is, at the beginning, caused embarrassment and confusion about how the learner to start his/her work?
- Is there continuous feedback so that he/she knows what to do?
- Seems clear that its is requested to engage in the process of understanding of the poet's life and then to approach the poetic creation with his/her experiential perspective?

2. Match between learning design and the real world:

- Does the LD use words, phrases, concepts familiar to the learner?
- Are the cognitive patterns of interface appropriate for the level of all personas created?
- Does the LD make learner understand that must perceive the poem through his/her thoughts, feelings and experiences?
- Are informations appeared in natural and logical order?

3. User control and freedom:

Does the LD allow the learner to understanding his mistakes and returning to the previous sections, so that start from the beginning?

4 . Recognition rather than recall:

- Are instructions to use all the tools available and easily useable?
- Does the LD provide user-friendly and clear directions when the learner requests assistance?

Figure 4. Heuristic protocol of P1, first heuristics from her adapted set

Most participants applied a very simple approach as seen from the analysis of the selection of the specific heuristics they adopted. Table 7 lists all heuristics defined by the original authors (Benson et al., 2001; Ssemugabi & de Villiers, 2010). It is important to notice that the order of the heuristics in these two existing heuristics sets marked the selection of heuristics that participants made. Thus, we can see how the first three heuristics are also the three most selected ones. Table 7 also notes whether a specific heuristic is part of the general usability criteria or part of the educational criteria. The order approach that participants followed as well as the first protocol (Figure 4) resulted in a predominance of usability heuristics over pedagogical heuristics. Note that, given that participants had not yet decided which ICT tool they would select for their learning activity, pedagogical heuristics are the more adequate for the task.

Table 7
Number of participants who selected a particular heuristic

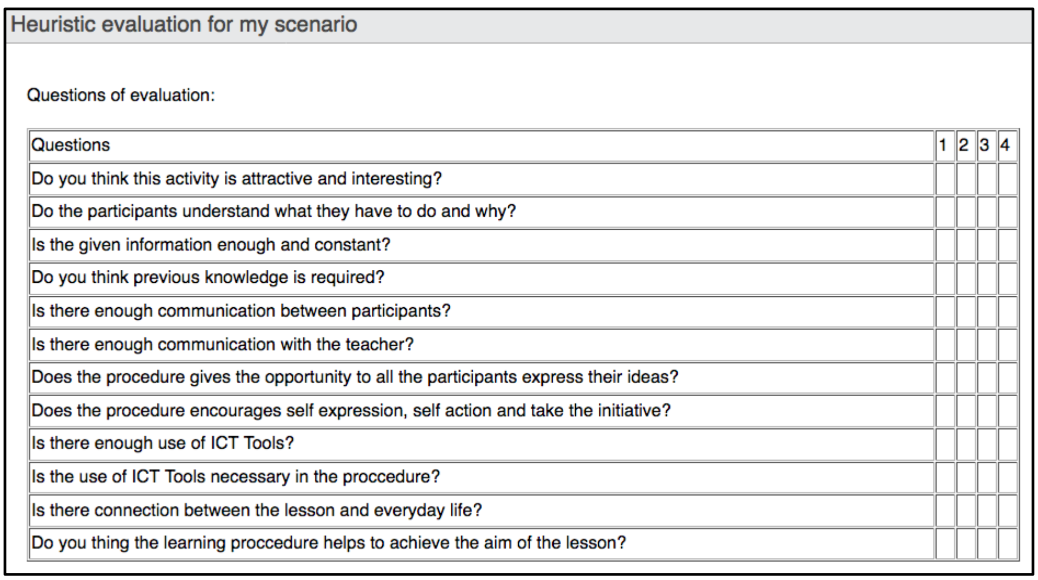
No. of participants who included the heuristic	Type of heuristic	Title of heuristic	Order of heuristics by Benson et al. (2001)	Order of heuristics by Ssemugabi & de Villiers (2010)
17	General interface usability criteria	Match between the system and the real world, i.e., match between designer model and user model	2	2
17	General interface usability criteria	User / learner control and freedom	3	3
14	General interface	Visibility of system status	1	1

	usability criteria			
13	Educational criteria	Media integration	15	N/A
11	General interface usability criteria	Recognition rather than recall	6	6
11	General interface usability criteria	Flexibility and efficiency of use	7	7
11	General interface usability criteria	Interactivity	11	N/A
10	General interface usability criteria	Aesthetic and minimalist design	8	8
10	General interface usability criteria	Recognition, diagnosis, and recovery from errors	9	9
10	Educational criteria	Resources – Support for personally significant approaches to learning	16	16
10	General interface usability criteria	Feedback	19	N/A
8	General interface usability criteria	Help and documentation	10	10
8	General interface usability criteria / Educational criteria	Content	20	N/A
8	Educational criteria	Learner motivation, creativity and active learning	N/A	20
6	General interface usability criteria	Error prevention, in particular, prevention of peripheral usability-related errors	5	5
6	Educational criteria	Learning design (2 of the artefacts referred to this as "Learning Design Management")	13	N/A
6	Educational criteria	Clarity of goals, objectives and outcomes	N/A	13
6	Educational criteria	Effectiveness of collaborative learning (where such is available)	N/A	14
4	Educational criteria	Assessment	14	N/A
4	Educational criteria	Feedback, guidance and assessment	N/A	18
3	General interface usability criteria	Cognitive error recognition, diagnosis and recovery	N/A	17
2	General interface usability criteria	Consistency and adherence to standards	4	4
1	General interface usability criteria / Educational criteria	Message design	12	N/A
1	Educational criteria	Learning management	18	N/A

1	Educational criteria	Relevance of site content to the learner and the learner process	N/A	12
1	Educational criteria	Context meaningful to domain and learner	N/A	19
1	Educational criteria	Level of learner control	N/A	15
0	General interface usability criteria / Educational criteria	Performance support tools	17	N/A
0	General interface usability criteria	Simplicity of site navigation, organisation and structure	N/A	11

Heuristic protocols as a set of questions

As noted, the protocols based on questions represent a different trend in what participants did to define them. As with the previous protocols, these questions were also based on the set of heuristics provided. However, the question-based protocols differ more from the sets provided and the adapted protocols in several ways: the concept of a heuristic is understood as questions to assess the design with, the type of heuristics that the questions were based on as well as the number of rules of thumbs included. Figure 5 shows the protocol from the first participant to publish a question format in the discussion forum.


Heuristic evaluation for my scenario

Questions of evaluation:

Questions	1	2	3	4
Do you think this activity is attractive and interesting?				
Do the participants understand what they have to do and why?				
Is the given information enough and constant?				
Do you think previous knowledge is required?				
Is there enough communication between participants?				
Is there enough communication with the teacher?				
Does the procedure gives the opportunity to all the participants express their ideas?				
Does the procedure encourages self expression, self action and take the initiative?				
Is there enough use of ICT Tools?				
Is the use of ICT Tools necessary in the proccedure?				
Is there connection between the lesson and everyday life?				
Do you thing the learning proccedure helps to achieve the aim of the lesson?				

Figure 5. Heuristic protocol of P5

Analysing the question-based protocols, we see how, in contrast with the adapted formats, the types of questions are more related to the design of the ICT-based learning activity than to the usability aspects. For example, mapping the questions to a heuristic statement from the existing sets we see that "Learner motivation, creativity and active learning" is the rule of thumb preferred by participants with questions (76.9%) over those who adapted the heuristics (40%).

How their design thinking unfolded (Topic 2)

The design task on heuristic evaluation was part of the Week 3 activities. Within the overall MOOC, Week 3 activities were perceived as more difficult than the rest (Figure 6). Therefore, the overall experience with the HE method was negative, which is confirmed by some of the comments in the discussion forums. As Table 8 shows, participants expressed both their lack of understanding and their uncertainty with the produced artefact, independently of the type of artefact produced.

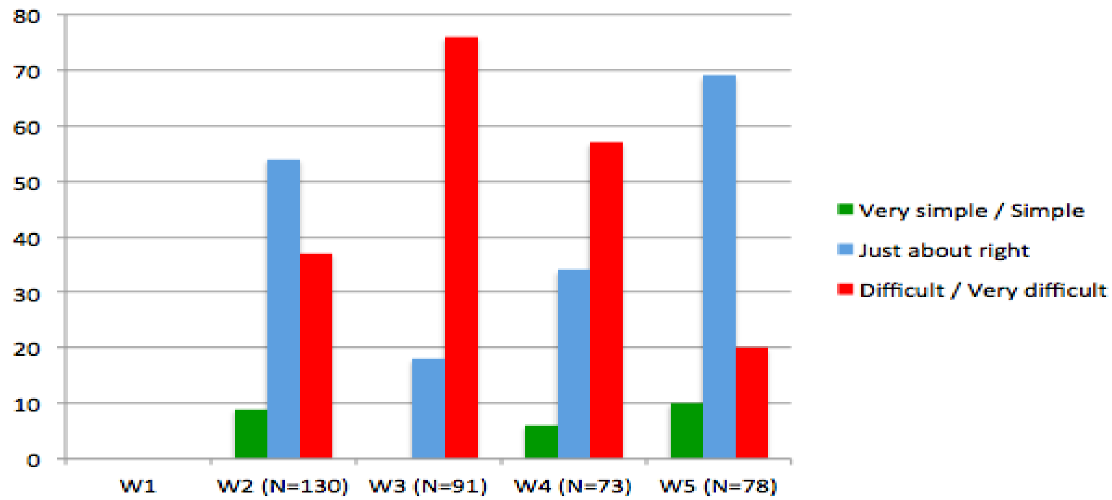


Figure 6. The level of difficulty of weekly activities, extracted from the questionnaires sent out weekly (in %)

In contrast with this negativity, some qualitative data show positive attitudes towards the HE method. Table 8 shows indications that – mostly when reflecting on the task [LearnJ] (Table 2) – some participants saw the value of the heuristic evaluation method and thus understood its role in the design process.

Table 8
Coded participant comments and type of artefact produced

Participant	Type	Lack of understanding of the design task	Uncertainty towards the produced artefact	Positive attitude towards the HE method
P1	Adaptation	"Define the Heuristics! Very difficult issue as to the exact wording of my thoughts…" [+ *text copied from the task activity*] [LearnJ]	"I updated my Heuristic Evaluation (especially in "Your Task"). I do not know if it is still correct." [DisFor]	
P3	Adaptation	"Professor is it possible to explain us a little bit more? Thanks anyway" [DisFor]	"Here is my Heuristic evaluation protocol. Of course I am not sure if I did it right after Professor's notice." [DisFor]	"In order to evaluate our learning design and not to lose time and be an effortful procedure, we use heuristic evaluation. A useful tool and we have to keep in mind that the earlier you run an evaluation activity on your design the less costly it will be. That is why evaluating soon and often is highly recommended." [DisFor]

P5	Questions	"Activity 13 This was complicated! Heuristics really left me with a headache." [DisFor]	"I think an example would have been useful before this activity. None of us seems to be sure of the result." [DisFor]	"I liked it a lot, the subject is really interesting and as a theologist i can do like this, for example, in the parable of the good samaritan and how to show love to others." [DisFor]
P6	Adaptation	"After a long struggle with this activity I have finally completed it." [DisFor]	[PARTICIPANT'S NAME, P23] thank you for your comments ... we are all struggling here ... and learning from each other. I am very happy to share my work with others. I think this is what this seminar is about. Creating usable resources!!! [DisFor]	"I used my Heuristics Evaluation Protocol combined with the principles of the Cognitive Walkthrough and Constructive Interaction approaches which I found most applicable to my activity. The whole process tested also my Heuristics which I found very interesting." [LearnJ]
P7	Questions		"To be honest I'm not sure if this is what you had in mind." [DisFor]	"Gone through the heuristics material provided and think I got the point. It's a great idea to review learning designs before you use them. It helps you avoid designing mistakes." [LearnJ]
P10	Adaptation		"My Heuristic evaluation - Activity 13- related to a scenario of a lesson in my class is here. I would appreciate the feedback!! Thanks" [DisFor]	"The truth is that after all the work I finally realised that I was very happy with the outcome. The evaluation is so much important for a learning design [...] it is then that you truly understand what exactly you are doing - what are your goals in accordance with your design - if what you ask is in accordance with the context of your persona or not?"

To further understand the position of the HE design task in the overall MOOC, Figure 7 shows the perceptions participants had for each activity separately (as the percentage of participants who gave a particular verdict). All perceived usefulness verdicts score over 80%, including the heuristic design task. However, the heuristic design task has the lowest score at 84.6%. To reinforce this picture, it is also the task that was most perceived as "not useful" or "kind of useful" (15.4%). Thus, despite some positive comments towards the HE design task (Table 8), it resulted in little actionable knowledge.

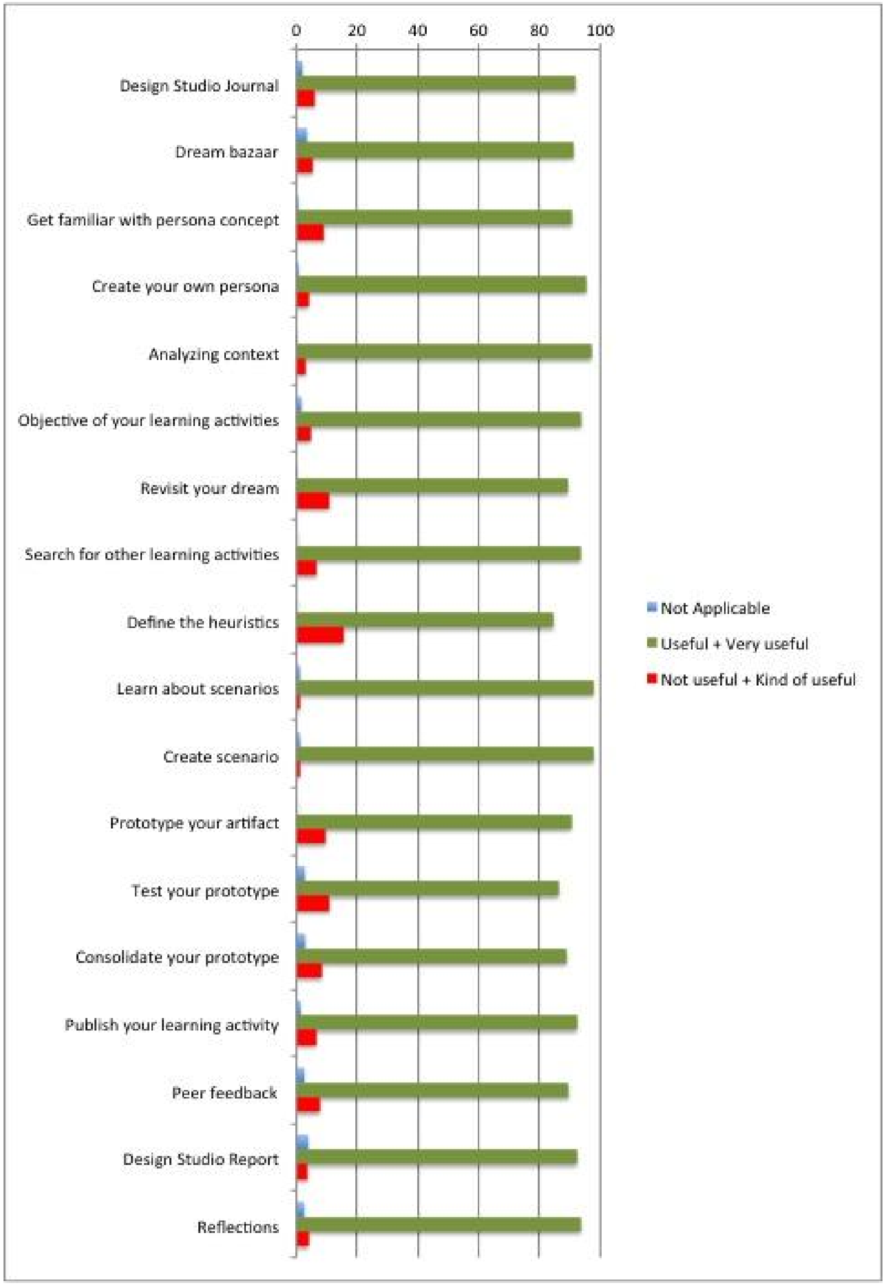


Figure 7. Answers to the level of usefulness of weekly activities (in %). Bars indicate the percentage of participants providing a score of “not applicable”, “very useful or useful”, or “not useful or kind of useful”.

Discussion, conclusions and design implications

The theoretical research issue that triggered the present study is: Does the concept of heuristics and the method of heuristic evaluation provide actionable knowledge for design in education? To answer it, we opted for an empirical and exploratory methodology, working with educators and focusing on the "knowledge that is sufficient to inform action in the world" (Goodyear, 2015, p. 38). Within this context, the specific research question we set out to answer is: How does a design task based on the HE method perform in a realistic teacher training setting? We elaborated the question to encompass two topics: *How do participants accomplish this task?* (Topic 1) and *How does their design thinking unfold?* (Topic 2).

With respect to Topic 1, we focused on the artefacts the participants produced and on how they did so. As indicated, the educational set-up purposely lacked teacher-led scaffolding; indeed, some participants may have seen the design task as internally inconsistent. The rationale for our choice lies in the research question. We intentionally left the approach open as heuristics – both educational and human-centred design ones – may be used for a variety of different purposes. We summarise the approaches as *ad hoc design principles* versus the *usage of existing heuristics*. It is key to answering our research question to understand which one of these two approaches is more actionable.

The results indicate that, when confronted with a lack of guidance, participants opted for the existing heuristics approach: most participants based their own heuristics productions on the existing sets of heuristics provided, and/or on the artefacts that their fellows shared in the discussion forum. We assume that it is their expressed lack of understanding of the task or its perceived difficulty that lead participants to select and adapt existing heuristics rather than create novel ones from scratch.

The analysis of the heuristic evaluation protocols produced also shows that general usability-interface criteria prevail over educational ones. The reason may be that the participants were asked to design an ICT-based learning activity. Another explanation could reside in the practice-driven approach that educators use when designing for learning, together with the concept of pedagogical knowledge-in-pieces (Goodyear, Markauskaite, & Kali, 2009). However, a more in-depth analysis led us to distinguish between three types of protocols created. Some participants selected and adapted their heuristics from a single set of the ones provided; others preferred to choose from different sets and subsequently adapt protocols. Yet others – admittedly a few only – produced a set of questions themselves. Though these participants also started with the existing sets of heuristics, they diverged more from them than did the others. Interestingly, their protocols also included more educational design heuristics. Arguably, this group had the deepest understanding of the heuristic evaluation knowledge that was provided to them and, subsequently, made the best use of it.

And how did the participants' design thinking develop over time? (See Topic 2.) To tackle this question, we analysed the comments and reflections in the discussion forum and the learning journals. We defined three themes that include the chronological order in the unfolding of the participants' design thinking: lack of understanding of the design task, uncertainty towards the artefact produced, and finally a positive attitude towards the HE method. The results show that the perceived level of difficulty – both in understanding and producing – can be counterbalanced by some positive comments towards the value of the heuristic evaluation method.

Despite these two positive signs – that is, the emergence of question-based protocols under Topic 1 and the positive attitude towards HE under Topic 2 – we cannot but conclude that neither the setting (the HANDSON MOOC) nor the design task as it was formulated allowed educators to leverage the purported advantages of HE to the full (first conclusion). To them, HE knowledge was actionable only to a limited extent. Perhaps, the word "heuristic" was more of a barrier to comprehension than we anticipated. The same task under the heading of "design principle" or "rule of thumb" may have lowered their perception of difficulty. The rest of the human-centred design methods implemented in the epistemic design of the MOOC did not involve such domain-specific wordings. Is that why these did not generate this combined perception of high difficulty and low usefulness? Clearly, more research is needed here. Furthermore, we likely have witnessed a first-mover effect. The first protocol published probably set an example that many other participants chose to follow, perhaps preventing them from investing more in devising protocols of their own making. Finally, our choice to leave the approach to the formulation of heuristics open, that is, to do away with scaffolding completely, may have proved too hard on many participants, however sensible our choice may have seemed at the outset. So, the provision of scaffolds, from using existing protocols to devising new ones de novo, may prompt the desired effect of using HE principles as actionable knowledge.

Remember that HE is considered to be easy to learn, efficient, and time- and cost-effective (Albion, 1999; Nielsen & Mack, 1994; Ssemugabi & de Villiers, 2010). So, there is every reason to try and capitalise on the benefits that HE has to offer, particularly in the present day and age. The almost constant cutting of education budgets (e.g., Goodyear, 2015), the push for technology in education (Dubos, 2013) as well as the day-to-day reality of most educators (Bennett et al., 2015, 2016) calls for design methods that are low-cost, efficient and easy to apply. Our research may indicate a steep HE learning curve for educators, but that does not need to detract from HE's potential as a design tool. Besides, we believe that HE would also facilitate the reuse of existing learning resources as promoted by learning design field (Laurillard, 2012) as well as the assessment of one's own learning activities, as redesign is part of a continuous cycle of improvement (Bennett et al., 2015).

Drawing on the general knowledge that is available about heuristic evaluation, we still advocate HE as part of a design process that covers the entire teaching-learning lifecycle (Goodyear, 2015). But keeping in mind the results we presented here, we suggest that within this lifecycle HE may be of good use if the following practices are followed:

- Start with educational heuristics only. In the process of designing an ICT-based learning activity, provide educators with heuristics that focus solely on the learning design aspects. This knowledge of powerful design heuristics can also increase the efficiency and effectiveness of educators' design work (see also McKenney et al., 2015).
- Include an initial heuristic evaluation task. In our study, educators were asked to define their own heuristics. To reduce the apparent difficulty of this task, educators should first use existing educational heuristics to assess learning activities (scaffolding).
- Promote a question approach for the de novo creation of heuristics. Similar to the human-computer interaction method of "cognitive walkthrough" (Nielsen & Mack, 1994), educators seemed more comfortable reflecting through questions than through statements. This is aligned with the idea that the formulation of a question is key to the teacher inquiry process (see also Hansen & Wasson, 2016).
- Bring in user interface/usability heuristics at a later stage only. Once educators have worked on the goals and heuristics of their learning activity, they are more ready to move to the ICT part. Usability heuristics can then become a tool to assess existing technology.

Our study extends and enhances the existing pool of empirical research on how to build on teacher expertise to support teachers in their design efforts; it examines the use of human-centred design methods to empower the design capacity of educators and informs both practice and research in the fields of learning design. In other words, it fits with the idea that "the future progress in learning design R&D, [which] will require more and better research on users, their needs, contexts of use and the affordances of the various tools and resources that are meant to improve their design activity" (Kali et al., 2011, p. 130). If anything, our study supports a call for the creation of more (and better) links between human-centred design and learning design.

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References

Agostinho, S., Bennett, S., Lockyer, L., & Harper, B. (2011). The future of learning design. *Learning, Media & Technology, 36*(2), 97–99. https://doi.org/10.1080/17439884.2011.553619

Albion, P. R. (1999). Heuristic evaluation of educational multimedia: From theory to practice. In H. Goss (Ed.), *16th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education* (pp. 9–15). Retrieved from http://www.ascilite.org/conferences/brisbane99/papers/albion.pdf

Asensio-Pérez, J. I., Dimitriadis, Y., Pozzi, F., Hernández-Leo, D., Prieto, L. P., Persico, D., & Villagrá-Sobrino, S. L. (2017). Towards teaching as design: Exploring the interplay between full-lifecycle learning design tooling and teacher professional development. *Computers and Education, 114*, 92–116. https://doi.org/10.1016/j.compedu.2017.06.011

Beale, R., & Sharples, M. (2002). *Design guide for developers of educational software*. Canley: British Educational Communications and Technology Agency (BECTA).

Bencze, L., & Hodson, D. (1999). Changing practice by changing practice: Toward more authentic science and science curriculum development. *Journal of Research in Science Teaching, 36*(5), 521–539. https://doi.org/10.1002/(SICI)1098-2736(199905)36:5<521::AID-TEA2>3.0.CO;2-6

Bennett, S., Agostinho, S., & Lockyer, L. (2015). Technology tools to support learning design: Implications derived from an investigation of university teachers' design practices. *Computers & Education, 81*, 211–220. https://doi.org/10.1016/j.compedu.2014.10.016

Bennett, S., Agostinho, S., & Lockyer, L. (2016). The process of designing for learning: understanding teachers' design work. *Educational Technology Research and Development, 65*(1), 125–145. https://doi.org/ 10.1007/s11423-016-9469-y

Benson, L., Elliott, D., Grant, M., Holzschuh, D., Kim, B., Kim, H., … Reeves, T. (2001). *Heuristic evaluation instrument and protocol for e-learning programs*. Retrieved from http://treeves.coe.uga.edu/edit8350/HEIPEP.html

Boschman, F., McKenney, S., & Voogt, J. (2014). Understanding decision making in teachers' curriculum design approaches. *Educational Technology Research and Development, 62*(4), 393–416. https://doi.org/10.1007/s11528-016-0078-8

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brown, M., & Edelson, D. C. (2003). *Teaching as design: Can we better understand the ways in which teachers use materials so we can better design materials to support their changes in practice?* Evanston, IL: The Center for Learning Technologies in Urban Schools. Retrieved from http://www.inquirium.net/people/matt/teaching_as_design-Final.pdf

Creswell, J. W. (2009). *Research design: Qualitative, quantitative and mixed approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Dalziel, J., Conole, G., Wills, S., Walker, S., Bennett, S., Dobozy, E., … Bower, M. (2016). The Larnaca declaration on learning design. *Journal of Interactive Media in Education, 2016*(1), 1–24. https://doi.org/10.5334/jime.407h

Doyle, W., & Ponder, G. A. (1977). The practicality ethic in teacher decision-making. *Interchange, 8*(3), 1–12. https://doi.org/10.1007/BF01189290

Ertmer, P. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development, 47*(4), 47–61. https://doi.org/10.1007/BF02299597

Garreta-Domingo, M., Sloep, P., Hernández-Leo, D., & Mor, Y. (2017a). Design for collective intelligence: Pop-up communities in MOOCs. *AI & Society*, 1–10. https://doi.org/10.1007/s00146-017-0745-0

Garreta-Domingo, M., Sloep, P. B., Hernández-Leo, D., & Mor, Y. (2017b). Editorial: Learning design for teacher professional development. *International Journal of Educational Technology in Higher Education, 14*(36), 19–21. https://doi.org/10.1186/s41239-017-0074-x

Goodyear, P. (2015). Teaching as design. *HERDSA Review of Higher Education, 2*, 27–50. Retrieved from http://www.herdsa.org.au/wp-content/uploads/HERDSARHE2015v02p27.pdf

Goodyear, P., & Carvalho, L. (2014). Framing the analysis of learning network architectures. In L. Carvalho & P. M. Goodyear (Eds.), *The architecture of productive learning networks* (pp. 48–70). London: Routledge Falmer.
Goodyear, P., Markauskaite, L., & Kali, Y. (2009, December 10). *Learning design, design contexts and pedagogical knowledge-in-pieces.* Paper presented at the Future of Online Learning Conference, University of Wollongong. Retrieved from http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1001&context=fld
Hansen, C. J., & Wasson, B. (2016). Teacher inquiry into student learning: The TISL heart model and method for use in teachers' professional development. *Nordic Journal of Digital Literacy, 10*(1), 24–49. https://doi.org/ 10.18261/issn.1891-943x-2016-01-02
Hernández-Leo, D., Asensio-Pérez, J. I., Derntl, M., Prieto, L. P., & Chacón, J. (2014). ILDE: Community environment for conceptualizing, authoring and deploying learning activities. In S. De Freitas, C. Rensing, T. Ley, & P. J. Muñoz-Merino (Eds.), *EC-TEL 2014*. LNCS (Vol. 8719, pp. 490–493). Heidelberg: Springer. https://doi.org/ 10.1007/978-3-319-11200-8_48
Hoogveld, A., Paas, Jochems, W., & Van Merriënboer, J. (2002). Exploring teachers' instructional design practices from a systems design perspective. *Instructional Science, 30*(4), 291–305. https://doi.org/10.1023/A:1016081812908
Janssen, F., Westbroek, H., Doyle, W., & Van Driel, J. (2013). How to make innovations practical. *Teachers College Record, 115*(7), 1–42. https://doi.org/ 10.1016/j.tate.2011.07.003
Kali, Y., Goodyear, P. M., & Markauskaite, L. (2011). Researching design practices and design cognition: contexts, experiences and pedagogical knowledge-in-pieces. *Learning, Media and Technology,* 36(2), 129–149. https://doi.org/10.1080/17439884.2011.553621
Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. London: Routledge.
Markauskaite, L., & Goodyear, P. (2009). Designing for complex ICT-based learning: Understanding teacher thinking to help improve educational design. In R. J. Atkinson & C. McBeath (Eds.), *Same Places Different Spaces. Proceedings of the 26th Annual ascilite International Conference* (pp. 614–624). Auckland: The University of Auckland, Auckland University of Technology, and Australasian Society for Computers in Learning in Tertiary Education. Retrieved from http://www.ascilite.org/conferences/auckland09/procs/markauskaite.pdf
Matuk, C. F., Linn, M. C., & Eylon, B. S. (2015). Technology to support teachers using evidence from student work to customize technology-enhanced inquiry units. *Instructional Science, 43*(2), 229–257. https://doi.org/10.1007/s11251-014-9338-1
McKenney, S., Kali, Y., Markauskaite, L., & Voogt, J. (2015). Teacher design knowledge for technology enhanced learning: An ecological framework for investigating assets and needs. *Instructional Science, 43*(2), 181–202. https://doi.org/10.1007/s11251-014-9337-2
Mor, Y., & Mogilevsky, O. (2013). The learning design studio: Collaborative design inquiry as teachers' professional development. *Research in Learning Technology, 21*(1), 1–15. https://doi.org/10.3402/rlt.v21i0.22054
Mor, Y., Derntl, M., Hernández-Leo, D., Craft, B., Pozzi, F., Persico, D., … Retalis, S. (2011). *The learning design grid*. Retrieved from http://www.ld-grid.org/resources/methods-and-methodologies/heuristic-evaluation/
Nielsen, J., & Mack, R. L. (1994). *Usability inspection methods*. New York, NY: John Wiley & Sons.
Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information Systems Research*, 2(1), 1–28. https://doi.org/10.1287/isre.2.1.1
Penuel, W. R., & Gallagher, M. S. (2009). Preparing teachers to design instruction for deep understanding in middle school earth science. *Journal of the Learning Sciences, 18*(4), 461–508. https://doi.org/10.1080/10508400903191904
Quinn, C. N. (1996). Pragmatic evaluation: Lessons from usability. In A. Christie (Ed.), *Proceedings of the 13th Annual Conference for the Australasian Society for Computers in Learning in Tertiary Education*. Adelaide: University of South Australia. Retrieved from http://www.ascilite.org/conferences/adelaide96/papers/18.html

Reeves, T. C., Benson, L., Elliott, D., Grant, M., Holschuh, D., Kim, B., … Loh, C. S. (2002). Usability and instructional design heuristics for e-learning evaluation. In P. Barker & S. Rebelsky (Eds.), *World Conference on Educational Multimedia, Hypermedia and Telecommunications* (pp. 1615–1621). Waynesville, NC: AACE. Retrieved from https://www.learntechlib.org/j/EDMEDIA/v/2002/n/1/

Ssemugabi, S., & de Villiers, R. (2007). A comparative study of two usability evaluation methods using a web-based e-learning application. In L. Barnard & R. A. Botha (Eds.), *Proceedings of the 2007 annual research conference of the South African Institute of Computer Scientists and Information Technologists on IT Research in Developing Countries* (pp. 132–142). New York, NY: ACM. https://doi.org/10.1145/1292491.1292507

Ssemugabi, S., & De Villiers, M. R. (2010). Effectiveness of heuristic evaluation in usability evaluation of e-learning applications in higher education. *South African Computer Journal, 45*(July), 26–39. https://doi.org/10.18489/sacj.v45i0.37

Stake, R. E. (2010). *Qualitative research: Studying how things work*. London: The Guilford Press.

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Garreta-Domingo, M., Sloep, P., Hernández-Leo, D., & Mor, Y. (2017). Design for collective intelligence : Pop-up communities in MOOCs. *AI & Society*, *33*(1), 91–100. http://doi.org/10.1007/s00146-017-0745-0

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ORIGINAL ARTICLE

Design for collective intelligence: pop-up communities in MOOCs

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Abstract Many current authors point toward the heightening of networked individualism and how this affects community creation and engagement. This trend poses strong challenges to the potential beneficial effects of collective intelligence. Education is one of the realms that can strongly suffer from this globalized individualism. Learning is deeply enhanced by social interactions and losing this social dimension will have long-lasting effects in future generations. Networked learning is also a by-product of our societal context, but not per se individual. Our paper presents a case—the HANDSON massive open online course (MOOC)—in which a purposely designed learning environment fosters the emergence of a kind of collective intelligence which, by the learners own accord, brings about a heightened sense of community. The MOOC's design managed to enable individual learning paces without killing the social dimension. Thus, we argue that when learning together intentionally and informally in networked online environments, small and temporary communities (pop-up communities we call them) will form. This nascent sense of community is a first step that will ultimately contribute to the common good.

Keywords Collective intelligence · Learning design · Networked learning · MOOCs · Networked individualism · Pop-up community

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1 Introduction

In this day and age, as individuals we sit in the middle of a networked world, with massive amounts of information at keyboard's length, with vast numbers of individual people accessible through email, chat, social media, video conferencing and mobile phones, with few or no boundaries of time and space. Such a world differs in obvious ways from the pre-Internet world of only 25 years ago. As a consequence thereof, people conceive of social relations differently. Where in the past geographical space was decisive in one's choice of whom to connect with, at present what matters most is who these people are, what they do and how they can contribute in achieving one's own goals. In their book, *Networked: The New Social Operating System* Rainie and Wellman (2012) call this new conception of sociality *networked individualism*. According to them, it captures the particular way in which people socialize who have embraced the triple revolutions of adopting social networks, Internet, and mobile devices as integral parts of their lives.

Does this kind of individualism leave room for a genuine sense of community, one may wonder, for a willingness to collaborate and together achieve things that

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individuals are incapable of achieving alone? Robert Putnam (2000), using a wealth of American data, argues that we have become increasingly disconnected from family, friends, neighbours, indeed from our democratic structures. Our stock of social capital, he argues, has plummeted, tearing apart our (offline) communities and impoverishing our lives (see also O'Hallam O'Hallarn 2016). So, networked individualism may be an apt description of our present-day world, there is an urgent need to mitigate its ill effects. We do need to find ways to maintain the benefits that cyberspace, the Internet and social media afford us without doing away with our civil and civic society. In communication theory, for example, there is a worry that our discussions, when conducted online, have become more shallow and less aware of elementary social norms (ibid.). Likewise, in education there is a consensus that learning is deeply enhanced by social interactions (e.g. Dillenbourg 1999), but will they remain as beneficial when educational interactions go online? Indeed, social interactions, notably educational ones, should be constitutive of the collective intelligence that is to serve our future generations.

For sure, education is making ever more inroads into the networked world, in the context of non-formal learning (Carvalho and Goodyear 2014; Dron and Anderson 2014), but increasingly also in the context of formal education (Bates 2015; Carvalho and Goodyear 2014). This is to be welcomed, as it allows learners and teachers to seize unprecedented opportunities (Dalziel 2016; Laurillard 2012). Resources for learning may be searched for, found and read through, the constraints imposed by place and time may be overcome; and perhaps most importantly, connections with peer learners may be forged for learning together. Massive open online courses (MOOCs) provide a particularly apt example of this change towards networked learning (Haythornthwaite 2011; Siemens and Conole 2011; Sloep and Berlanga 2011). Being hailed as a revolution in education (Daniel 2012), MOOCs embrace Internet technology, and approach learners individually without burdening them with a curriculum, class or peer group.

Thus, online learning can be social but not necessarily taking advantage of collective intelligence for the benefit of mutual learning. MOOCs are a good example of this. Most massive open online courses—especially those designed as xMOOCs (Bates 2015)—have focused on the individual learner as a "networked individual". With this, we do not mean that social interactions among its students cannot happen; but that the design of the course was not designed to foster the social dimension of learning. We refer here to the principle of harnessing the collective intelligence of networks (Ilon 2012).

In fact, to make this principle actionable, many paths and mechanisms can be taken and implemented. However, they should all be able to answer the following questions in a given network—say a collection of individuals bound by a shared common interest, however, generic that may be—how can the joint intelligences of the network members be tapped into; how can they be orchestrated to engage in productive dialogue; how can this dialogue contribute to the benefit of the network as a whole the common good (as opposed to the benefits of the individuals that participate in it only); and how can networked individuals be convinced that contributing to this common good is valuable, even if they may not see the immediate benefits to themselves thereof? These are too many questions, and too complex at that, to address in a single paper. Here, we will rest content with illustrating, in the context of education and in particular networked learning, how a properly designed learning environment fosters the emergence of a kind of collective intelligence which, by the participants own accord, brings about a heightened sense of community. We will then argue that this sense of community is the basis upon which common goods can be built.

In the present context, we will focus on networked forms of learning only. We do so as they embrace the online world in ways similar to networked individualism. Networked learning should therefore be liable to the same threats and dangers that networked individualism is exposed to. We will be looking at a particular instance of networked learning, a MOOC-based course. Networked individualism predicts that people will only engage in social interactions if they individually profit from this. At face value, this does seem to be the case in our study. However, when looking more closely, participants admit that they did experience the emergence of a sense of community. We will discuss how, in our view, this shift in attitude came about in the present network. We will argue that when learning together intentionally and informally in networked online environments, small and temporary communities (pop-up communities we call them) will form. In the short run, they only serve the immediate learning needs of their participants. However, through them weak links are explored and potentially longer-lasting relationships are forged (Haythornthwaite 2011). These pop-up communities, we argue, represent a kind of collective intelligence. In the short term, they may seem to serve the private good of its participants only. However, if weak links solidify into stronger ones, pop-up communities give rise to genuine communities, in which contributing to the common good is the norm. Thus, we see how MOOC platforms are socio-technological systems that have the potential to promote collective intelligence for the common good of mutually learning together as a network. However, the design of the environment that can facilitate this presents challenges. The paper discusses the challenge of addressing the social dimension of learning to cater for an open and large group formed by a multilingual audience. The aim is twofold facilitate individual learning paces while leveraging the power of peers, and move from a centrally facilitated to a decentralised, autonomous community.

The rest of this paper is organised as follows. First, we will discuss our approach to designing networked-learning MOOCs for continuous professional development (Sect. 2). Then in Sect. 3 we will look at the results of two studies we carried out, in subsequent editions of one and the same MOOC (HANDSON) and at the results of a facilitator survey. Then we will draw some conclusions and discuss how they address our initial design challenge.

2 The case of a MOOC for teacher training

2.1 The design of the MOOC

The HANDSON project (handsonict.eu), funded by the European Commission, is aimed at providing in-service teachers with the necessary skills to include ICT tools in their teaching. Although ICT has been around for some time, its inclusion in the classrooms and lecture halls still leaves to be desired (OECD 2015). To accomplish this, the project designed and subsequently developed a MOOC that guides teachers through a lesson design process. The design of the MOOC makes use of Goodyear and Carvalho's ACAD framework (Goodyear and Carvalho 2014). ACAD discerns three design components. The epistemic design concerns the tasks learners carry out to acquire new knowledge. The set and social designs concern the 'environment' in which the learner operates, the resources, tools, procedures, etc., that they make use of (set design) and their peers, teacher, tutors, etc., with whom they interact (social design). The very first design ideas for the MOOC were piloted with experts only (Stoyanov et al. 2014). Informed by their comments, two different editions of the MOOC were run, the second edition profiting from insights gained during the first one (Garreta-Domingo and Colas 2015). Though sharing many aspects, they differed in a few key ones, mostly in their social design. We will describe commonalities first, later to discuss differences.

The *epistemic design* for the HANDSON MOOC emphasized a hands-on, project-based approach. It required participants to act as learning designers themselves (Garreta-Domingo et al. 2015a) and design an ICT-based learning activity ready to use in their own lessons. During the five weeks of the MOOC, participants carried out a series of design tasks, working their way through five subsequent, week-long design phases initiate, investigate, inspire and ideate, prototype, and evaluate and reflect. This phased course outline is an adaptation of the *Learning Design Studio* approach by Mor and Mogilevsky (2013).

The *set design* comprised several tools and environments:

- An open source virtual (online) learning environment (VLE) as the course platform.
- An *Integrated Learning Design Environment* (ILDE, ilde.upf.edu/about) (Hernández-Leo et al. 2014).
- Google Hangouts for the weekly convergence sessions, and
- various web 2.0 tools for prototyping purposes.

The *social design* concerns the way the facilitators interacted with the participants and the participants with each other. Going from the first to the second edition, facilitator involvement was made more intense. But perhaps even more importantly, while in the first edition all course business was conducted in English only, in the second edition the materials were still made available in English, but seven language groups were established in which participants could interact with each other and their facilitators in the language of their choice, often their native language (Colas et al. 2016). Table 1 summarizes all changes made between the two editions.

The first edition of the HANDSON MOOC was offered from May 19th to June 20th of 2014. It counted 743 participants from 42 countries, the largest group coming from

Table 1 Summary of design differences between the two editions of the HANDSON MOOC

	First edition	Second edition
Epistemic design	20 tasks set to participants (in English)	23 tasks set to participants (in English)
	Two tasks related to evaluation protocols	Peer-mentoring tasks part of the course; one task for evaluation
Set design	Course VLE: Moodle	Course VLE: Canvas
Social design	English only peer-feedback, public and promoted by facilitators.	One peer-review task per week with rubrics, private to peers involved in task. Feedback was given in one of the seven languages supported.
	On Moodle and ILDE	On Canvas

Greece (58% of initial participants). The MOOC featured three paid facilitators and one technical support person. 68 (9.1%) of the participants finished the MOOC, that is, obtained the final badge of "designers".

The second edition ran a few months later, from October 27th to November 28th of 2014. The number of participants registered more than doubled (from 734 to 1515). It had two paid facilitators, 15 active volunteer facilitators, and one technical support person. 92 (6.7%) of participants completed this second edition, and obtained the designer's badge.

To analyse the fates of the communities in both editions of the HANDSON MOOC, we tapped into the following sources of data:

1. Activity report from Moodle (first edition of the MOOC only).
2. Activity reports from ILDE, with a focus on the comments that facilitators and participants made with respect to each other's designs.
3. Run-time surveys, which were sent to the participants at the beginning and end of both editions.
4. Final survey, which was sent to the 15 active facilitators at the end of the HANDSON project.

2.2 Collective participant behaviour in the HANDSON MOOC

2.2.1 First edition

In terms of social design, the facilitators of the first edition engaged participants by kicking-off all communications, clarifying doubts, commenting on participant's designs for learning with ICT, and in general promoting the interaction among participants. The social network graphs in Fig. 1 show how the interaction in the forums developed over course time, that is, how the number of messages from participants (orange nodes) increased and the number of messages from facilitators (blue nodes) decreased (Garreta-Domingo et al. 2015b). This suggests that thanks to the course's social design the participants increasingly adopted their role of peers. Table 2 reinforces this picture, showing how the number of participant messages almost monotonously grew from 3.04 to 5.35 (final column). Interestingly, this trend is not reflected in the number of messages per discussion thread (one but final column), fluctuating between 13.8 (week 2) and 2.8 (week 5). However, this does not gainsay our earlier finding as thread numbers are

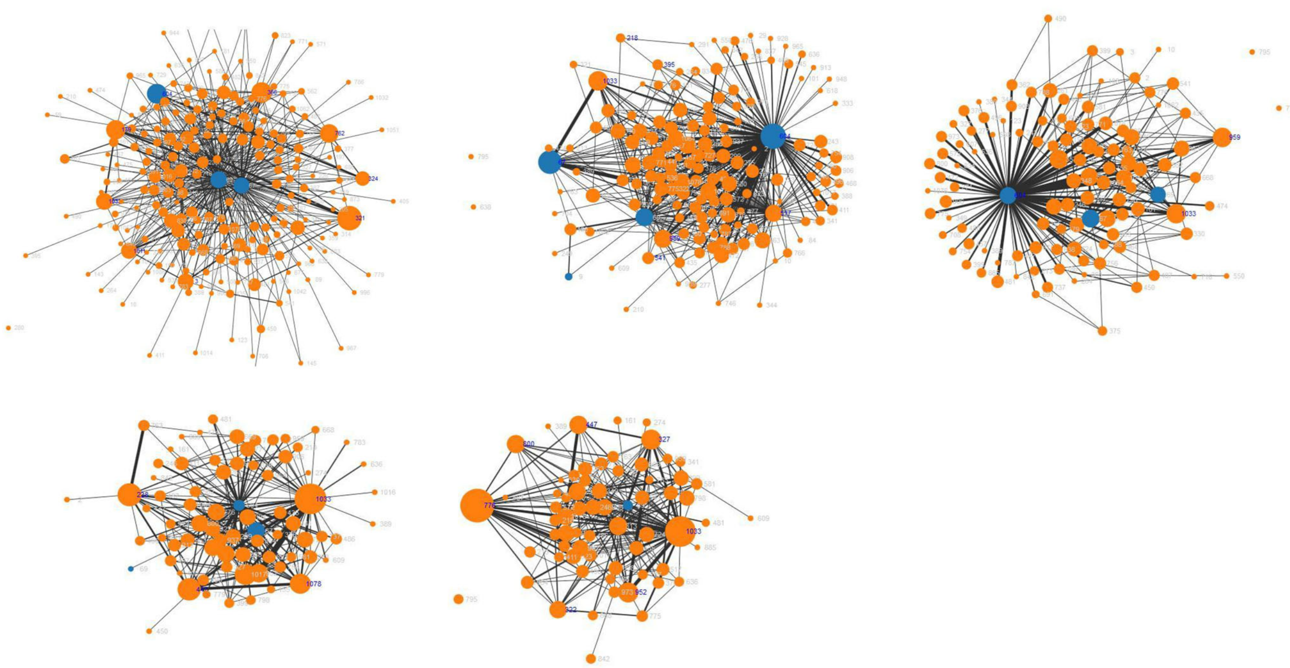

Fig. 1 Social network graphs depicting interactions in the weekly Moodle forums for the first edition of the HANDSON MOOC; ordered from week 1 to 5. Each *dot* ('node') represents actor MOOC participants in *orange*, facilitators in *blue*, the size reflecting the number of messages sent. *Lines* ('edges') indicate the exchange of at least one message, the *line thickness* reflecting the number of messages exchanged

Table 2 Interactions in the weekly Moodle forums for the first edition of the HANDSON MOOC

Course phase	Participants	Discussion threads created	Total number of messages	Av. number of participants per thread	Av. number of messages per participant
1st week forum	218	40	663	5.05	3.04
2nd week forum	152	11	656	13.8	4.31
3rd week forum	114	19	466	6.0	4.08
4th week forum	75	8	377	9.4	5.02
5th week forum	67	24	359	2.8	5.35
Total	626	102	2521	6.2	4.02

likely to reflect the number and complexity of facilitator-set tasks. So, we may conclude that, as the course advanced, the participants took a more prominent role in the communication and interaction in the forums, suggesting forms of community formation were taking place, as intended by the social design.

Despite the rather intense level of course activity, the interactions in the Moodle forums (which encompass any action, not just messaging) ceased once the MOOC finished (the course platform remained open after week 5, though). Figure 2 depicts the Moodle activity over time. It clearly shows how the activity peaked at the beginning of the MOOC (start date May 19), slowly fell off during the MOOC's runtime, and then—after the final week on June 20—quickly fell back to no activity at all. The same pattern is repeated in the design environment (ILDE), as Fig. 3 shows.

These data in Figs. 2 and 3 from the Moodle and ILDE platforms, respectively, are complemented by the data the participants themselves reported (Tables 3, 4). The tables show survey responses related to the communicative and collaborative aspects of the MOOC. Table 3 shows participant responses to the pre-survey sent just before the start of the MOOC. Participants were asked to rate their agreement with four statements. Their answers reveal they felt collaboration and interaction with peers was less relevant (at 55.9%) than with tutors and facilitators (72.2 and 83.9%). This suggests that, at the start of the MOOC, participants did not so much intend to contribute to community formation (as Table 2; Fig. 1 suggest) but were individually seeking to

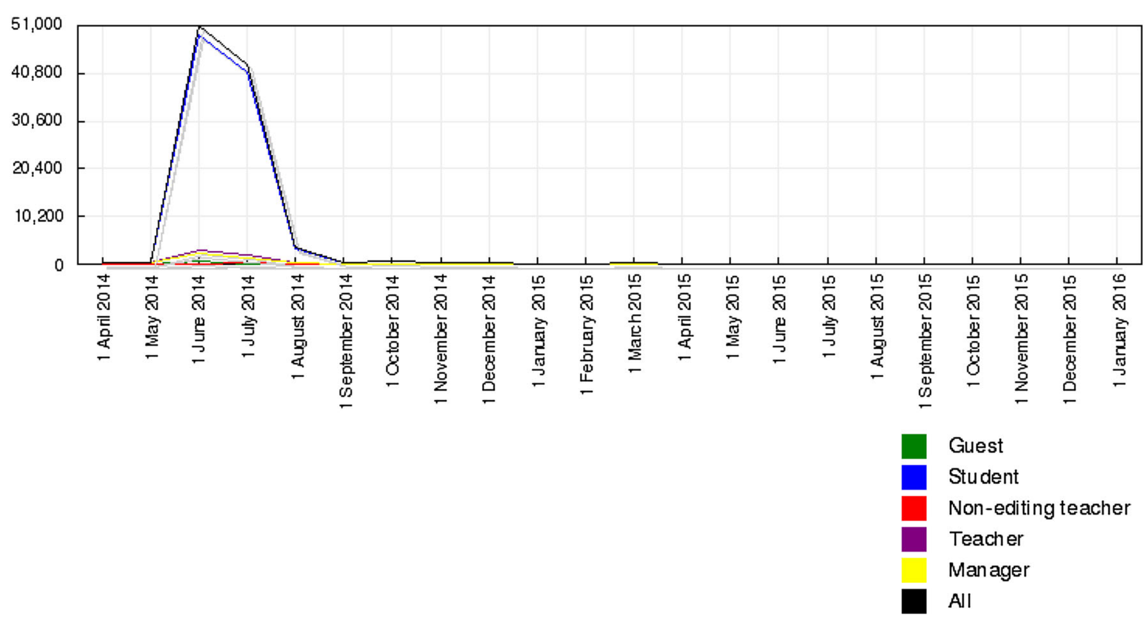

Fig. 2 Activity report for the Moodle platform during the first edition of the HANDSON MOOC. Activities amount to any interaction with the platform

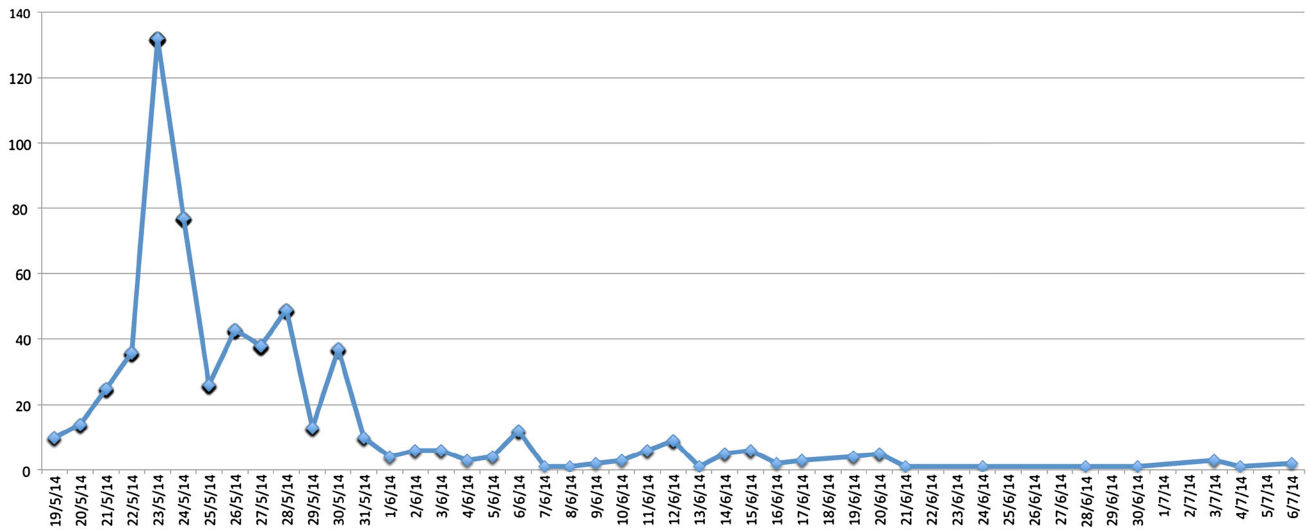

Fig. 3 Time-stamped numbers of comments to learning designs in the ILDE environment for the first edition of the HANDSON MOOC

Table 3 Responses to selected pre-survey questions for the first edition of the HANDSON MOOC

Question	Agree	Undecided	Disagree
Interaction with other course participants	55.9	27.7	16.4
Interaction with a facilitator/tutor	72.2	21.2	6.5
Facilitators/tutors feedback on participants activity	83.9	12.5	3.7
Collaborative work	60.7	25.9	13.5
Average	68.18	21.83	10.03

Responses in percentages; participants were asked to what extent they agreed with the statements given when attending an online course; total number of respondents to the survey 325

Table 4 Responses to selected post-survey questions for the first edition of the HANDSON MOOC

Question	Agree	Undecided	Disagree
The course provided a sense of community	76.7	16.9	6.3
The course has promoted interaction with my peers	67.6	26.1	6.3
The feedback I received from the course team was useful	57.7	31.0	11.2
The feedback I received from my peers was useful	55.6	28.2	16.2
Average	64.40	25.55	10.00

Responses in percentages; participants were asked to what extent they agreed with the statements given when attending an online course; total number of respondents to the survey 142

increase their learning outcomes by connecting with facilitators. However, when asked specifically about community formation aspects after the course (Table 4), 76.7% agreed that a sense of community had arisen, with an average of 64.4% (of the entire group) agreeing about the usefulness of this.

2.2.2 *Second edition*

As indicated in Table 1, in the second edition of the HANDSON MOOC participants could communicate with each other in any one of seven languages (Bulgarian, Catalan, English, Greek, Spanish, French, and Slovenian). Although the learning activities, the course materials and the general announcements remained in English only, the participants had to join any one of the seven language groups before they could actually follow the course. The rationale for this social design change was to facilitate and promote interaction among participants to create a sense of community. The assumption, based on positive experiences with an impromptu Greek-only group in the first edition, was that community formation is more likely to occur if one is able to speak one's native tongue or at least a language one is fluent in. With community formation, we intended to further increase the quality of the feedback that participants received from their peers (Colas et al. 2016; Garreta-Domingo et al. 2015a).

Unfortunately, the Canvas VLE used for this second edition did not allow us to make a social network analysis. However, as did Figs. 3 and 4 show the number of comments that peers made on the learning designs that MOOC participants created during the course. As in Fig. 3, we see how the activity peaked at the beginning of the course. However, Fig. 4 also shows much more variation in activity levels than did Fig. 3. Presumably, the activity peaks and troughs are synchronised with the tasks the MOOC participants were required to carry out. Remember how for the second edition peer-mentoring tasks were an explicit part of the epistemic design. In the first edition, participants were invited but not obliged to comment (cf. Table 1). This kind of synchronisation we spotted in the first edition as well, but there it only became apparent through the fluctuating numbers of discussion threads.

As in the first edition, pre- and post-MOOC surveys were sent out to participants (Tables 5, 6). Here too, initially the course participants were not really interested in interacting and collaborating with each other as peers and expected to get more from their facilitators, despite the supposedly stronger feeling of community that a shared language supposedly brings (Table 5).

However, as in the first edition, in due time participants arrived at the agreement that a sense of community had arisen (Table 6, 74.4%, compare with 76.7% in Table 4). This is also reflected in their answers to the more specific question about the usefulness of peer and facilitator interaction (Table 6, average level of agreement 70.10%, compared with 64.4% for the first edition—Table 4). As the increased percentage for the second edition is solely due to the higher appreciation of the feedback, it is likely this should be attributed to the fact that peer and facilitator interaction was conducted in each participant's own preferred language; together with the added value from the rubrics for the mandatory peer-review activities (cf. Table 1). This is more likely as the content expertise of the volunteer facilitators was lower than those of the paid facilitators. Thus, the many volunteer facilitators were less able to give feedback on the specifics of the course content and activities.

In an effort to learn about the fate of the language communities, six months after the ending of the HANDSON MOOC project, a short survey was sent out to the 15 volunteer facilitators for the second edition. The nine facilitators that responded confirmed that all activity in their language communities had ceased, with the exception of the Greek and English ones. We presume this is due to the fact that the entire Greek group of participants and part of the English group were recruited from existing online communities (Colas et al. 2016).

3 In conclusion: pop-up communities for the common good

The data gathered from the first edition of the MOOC suggest that participants came to it with their individual aims and goals, as networked individualism would have it. However, over the course of the course, peer interaction

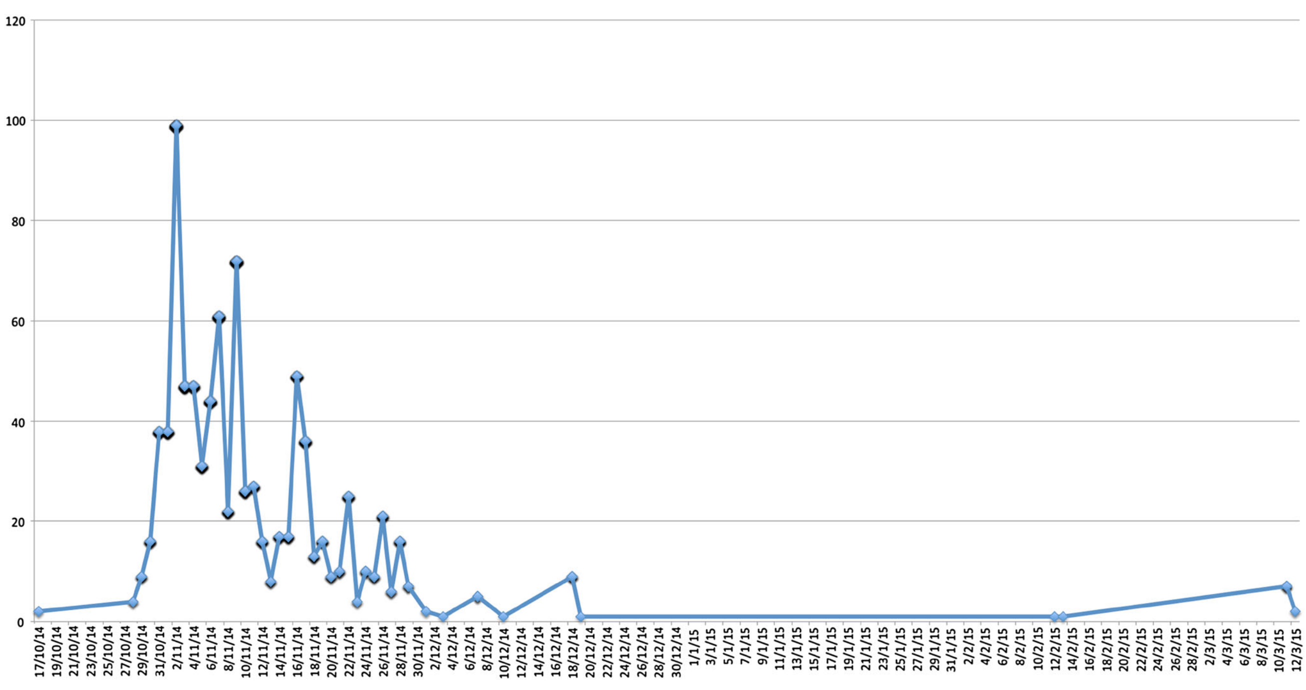

Fig. 4 Time-stamped numbers of comments to learning designs in the ILDE environment for the second edition of the HANDSON MOOC

Table 5 Responses to selected pre-survey questions for the second edition of the HANDSON MOOC

Question	Agree	Undecided	Disagree
Interaction with other course participants	55.1	30.1	14.8
Interaction with a facilitator/tutor	68.8	20.8	10.3
Facilitators/tutors feedback on participants activity	73.8	17.7	8.4
Collaborative work	54.0	28.8	17.1
Average	62.93	24.35	12.65

Responses in percentages; participants were asked to what extent they agreed with the factors given when attending an online course; 27.4% respondents came from Spain, 14.3% from Greece and 13.7% from Bulgaria (totalling 55.4% of all respondents); total number of respondents to the survey 379

Table 6 Responses to selected post-survey questions for the second edition of the HANDSON MOOC

Questions	Agree	Undecided	Disagree
The course provided a sense of community	74.4	15.9	9.7
The course has promoted interaction with my peers	64.6	24.4	11.0
The feedback I received from the course team helped me with my learning activities	75.6	15.9	8.5
The feedback I received from my peers helped me with my learning activities	65.8	19.5	14.6
Average	70.10	18.93	10.95

Responses in percentages; participants were asked to what extent they agreed with the factors given when attending an online course; 24.3% respondents came from Spain, 21.9% from Greece and 28.0% from Bulgaria (totalling 74.2% of all respondents); total number of respondents to the survey 82

increased while facilitator interaction decreased. Apparently, the participants appreciated this and confessed to having developed a sense of community, which they welcomed. The second edition confirms this picture. Again, participants were happy to tend to their own goals and interests only, nevertheless, they appreciated the sense of community that developed over time. The fact that they received feedback in their own language, did not affect this sense of community (in either direction).

The development and appreciation of a sense of community seems to fly in the face of what networked individualism holds. It also mitigates the pessimistic scenario that Robert Putnam paints, at least for this miniature universum of MOOC-based networked learning. We assume that our observations describe a genuine phenomenon, as it is in line with observations of other learning theorists (e.g. Dron and Anderson 2014; Illeris 2007). The question then is what caused the participants to change their opinion, what is the mechanism behind this change?

We suggest that the social dynamics of such networks are driven by a special kind of community, which we call *pop-up communities*. They are unlike traditional communities, which usually do not aim to achieve a specific goal and typically are tightly knit and long lasting. Examples of such ‘ordinary’ communities are geographical communities as in villages and neighbourhoods, but also the communities of practice that emerge in and across companies (Brown and Duguid Brown and Duguid 2000; Wenger 1998). In contrast, pop-up communities are characterised by their purposefulness—they emerge for a specific purpose only, and their temporariness—they disappear once they have outlived that purpose. Although they are tightly knit during their existence, the weak bonds that have been established typically do not last long enough to become strong ones. We suggest that the communities that arose in the HANDSON MOOC discussed, particularly the language-specific ones from the second edition, are such pop-up communities. It is because participants establish a link with each other, even if ever so briefly that they can pursue their common goal, be it clarifying an issue, answering a question or completing a task. Note, how such communities fit the tenets of networked individualism. With appropriate mechanisms in place—simple searching, recommender systems, matching algorithms—network participants can ‘meet’ easily, without necessarily investing much in the transaction costs of setting up such meetings. And just as easily they may leave the community to go on with their own business and perhaps join another pop-up community with serves their then needs. Note, also, how this description of the network participants’ behaviour fits the expectations they themselves confess to have.

In the past, others have stumbled upon similar findings. Thus, in 2002 already Bonnie Nardi and colleagues described *intensional networks* in the context of computer-supported collaborative work (Nardi et al. 2002). Such networks take personal social networks as building blocks rather than top-down created teams. Then, in relation to open source software development, Steven Weber discusses *episodic communities on demand* "virtual organizations that come together frictionlessly for a particular task and then redistribute to the next task just as smoothly" (Weber 2004, p 171). Sloep (2009) introduces the notion of *ad hoc transient communities* to denote small groups of students, one of whom asks a question that the others answer in a collective, dedicated, and online discussion space (see also van Rosmalen et al. 2008).

It is our view that such short-lived communities that dedicate themselves to a simple goal exemplify networked individualism. However, their effect is not necessarily disruptive, as Putnam describes. Any pop-up community not only captures the collective intelligence of its participants, it also provides an opportunity for building on this collective intelligence and let it work for the common good. The weak links established in a pop-up community may grow into strong ones if the participants want to (see also Haythornthwaite 2002). The data collected show evidence for these participants become less focused on peer-tutor interactions and more on peer–peer interactions. Also, they confess in appreciating this shift in social communication patterns from one that is characteristic for education (peer to teacher/tutor) to one that is characteristic of equitable social relationships (peer to peer). Admittedly, the data also reveal that, given the short duration of the experience of several weeks, the peer-to-peer relationships did not last in the majority of the language communities. However, the fact that they did in the language communities that had a previous history, bodes well for our claim that pop-up communities may breed a sense of community that stimulates people to keep collaborating, and thus contribute to their common good. We may live in an age of networked individualism, as Rainie and Wellman claim (2012). However, this does not imply people would be unwilling to contribute to the common good. It only takes a different form and the mechanism through which such contributions come about is different. This paper suggests that pop-up communities are such a mechanism.

Ours is a specific case in the realm of education, and more specifically, in networked learning for in-service educators. It is a contribution to the galaxy of initiatives working towards the same purpose harnessing the collective intelligence of networks. The Statement of Principles of the Public Sphere Project (www.publicsphereproject.org) also addresses directly the aim of promoting the common good that networked individualism is threatening. These instances of collective intelligence can happen off-line, online and/or with the combination of both as is discussed by Bilandzic and Foth (2016). Looking further away in the galaxy, we find projects aligned in another dimension long-term versus. short-term. Joel Fredericks et al. (2015) studied the effect of a digital device deployed with a pop-up style format for the purpose of community engagement; whereas Hillary Cottam, from the participatory design perspective, has worked in projects to redefine public services (www.participle.net/ageing). She shows that through the creation of 'Circles' of people living close to each other, the demand for public services is diminished while a better; more personal and timely service is obtained. Through these different initiatives, we can grasp two current characteristics of the routes for collective intelligence for the common good they are wide in approach and scope; they are scattered and experimental. It is up to us to create the map that through convergence and intertwining can facilitate the much needed growth and strength.

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References

Bates T (2015) Teaching in a digital age. University of British Columbia, Vancouver

Bilandzic M, Foth M (2016) Designing hubs for connected learning—social, spatial and technological insights from Coworking, Hackerspaces and Meetup Groups. In: Carvalho L, Goodyear P, De Laat M (eds) Place-based spaces for networked learning. Routledge, London

Brown JS, Duguid P (2000) The social life of information. Harvard Business School Press, Boston

Carvalho L, Goodyear PM (2014) The architecture of productive learning networks. Routledge Falmer, New York

Colas J-F, Sloep PB, Garreta-Domingo M (2016) The effect of multilingual facilitation on active participation in MOOCs. Int Rev Res Open Distance Learn 17(4):280–314

Dalziel J (2016) Learning design: conceptualizing a framework for teaching and learning online. Routledge Taylor and Francis Group, New York and London

Daniel J (2012) Making sense of MOOCs: musings in a maze of myth, paradox and possibility. J Interact Media Educ 18:1–19

Dillenbourg P (1999) Collaborative Learning: cognitive and computational approaches. Advances in learning and instruction series. Elsevier Science, New York

Dron J, Anderson T (2014) Teaching crowds; learning and social media. AU Press, Athabasca

Fredericks J, Tomitsch M, Hespanhol L, McArthur I (2015) Digital Pop-Up. In: Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction on — OzCHI'15, pp 634–642

Garreta-Domingo M, Colas J-F (2015) Palm Reading of the HANDSON MOOC. Barcelona

Garreta-Domingo M, Aguado Roman G, Mor Y, Fernandez C, Riviou K (2015). A peer-mentoring approach for the continuous professional development of educators in a MOOC Setting. In:

Eden Annual Conference 2015 Expanding Learning Scenarios, Barcelona
Garreta-Domingo M, Hernández-Leo D, Mor Y, Sloep PB (2015) Teachers' perceptions about the HANDSON MOOC: a learning design studio case. In: Conole G, Rensing C, Konert J, Hutchison D (eds) Design for Teaching and Learning in a Networked World; Proceedings of the 10th European Conference on Technology Enhanced Learning, EC-TEL 2015 Toledo, Spain, September 15–18, 2015 Proceedings. Springer, Berlin and Heidelberg, pp 420–427
Goodyear PM, Carvalho L (2014) Framing the analysis of learning network architectures. In: Carvalho L, Goodyear PM (eds) The architecture of productive learning networks. Routledge Falmer, New York and London, pp 48–70
Haythornthwaite C (2002) Strong, weak, and latent ties and the impact of new media. Inf Soc 18(5):385–401
Haythornthwaite C (2011) Learning networks, crowds and communities. In: Proceedings of the 1st International Conference on Learning Analytics and Knowledge, LAK'11. ACM, New York, pp 18–22
Hernández-Leo D, Asensio-Pérez JI, Derntl M, Prieto LP, Chacón J (2014) ILDE: community environment for conceptualizing, authoring and deploying learning activities. In: De Freitas S, Rensing C, Ley T, Muñoz-Merino PJ (eds) EC-TEL 2014 LNCS, 8719th edn. Springer, Heidelberg, pp 490–493
Illeris K (2007) How we learn; learning and non-learning in school and beyond (English ed). Routledge, Abingdon
Ilon L (2012) How collective intelligence redefines education. In: Altmann J, Baumöl U, Krämer B (eds) Advances in collective intelligence 2011. Advances in intelligent and soft computing, vol 113. Springer, Berlin, Heidelberg, pp 91–102. doi:10.1007/978-3-642-25321-8_8
Laurillard D (2012) Teaching as a design science: building pedagogical patterns for learning and technology. Routledge, New York and London
Mor Y, Mogilevsky O (2013) The learning design studio: collaborative design inquiry as teachers' professional development. Res Learn Technol 21(1):1–15
Nardi BA, Whittaker S, Schwarz H (2002) NetWORKers and their activity in intensional networks. Comput Support Coop Work 11(1–2):205–242
OECD (2015) Students, computers and learning; making the connection. OECD Press, Paris
O'Hallarn B (2016) The public sphere and social capital: Unlikely allies in social media interactions? First Monday 21(10)
Putnam RD (2000) Bowling alone: the collapse and revival of american community. Simon & Schuster, New York
Rainie L, Wellman B (2012) Networked: the new social operating system. MIT Press, Cambridge
Siemens G, Conole G (2011) Special issue—connectivism: design and delivery of social networked learning. IRRODL 12(3):i–iv
Sloep PB, Berlanga AJ (2011) Learning networks, networked learning [Redes de Aprendizaje, Aprendizaje en Red]. Comunicar XIX(37):55–63
Sloep PB (2009) Fostering sociability in learning networks through ad-hoc transient communities. In: Purvis M, Savarimuthu BTR (eds) Computer-mediated social networking ICCMSN 2008 LNAI 5322. Springer, Berlin Heidelberg, pp 62–75
Stoyanov S, Sloep PB, De Bie M, Hermans V (2014) Teacher-training, ICT, Creativity, MOOC, Moodle - What pedagogy? In: Gómez Chova L, López Martínez A, Candel Torres I (eds) Proceedings of Edulearn 14 the Sixth International Conference on Education and New Learning Technologies. IATED Digital Library, Barcelona, pp 5678–5686
van Rosmalen P, Sloep PB, Brouns F, Kester L, Berlanga AJ, Bitter-Rijpkema ME, Koper R (2008) A model for online learner support based on selecting appropriate peer tutors. J Comput Assist Learn 24(6):483–493
Weber S (2004) The success of open source. Harvard University Press, Cambridge
Wenger E (1998) Communities of practice: learning, meaning, and identity. Cambridge Univ Press, Cambridge

Garreta-Domingo, M., Hernández-Leo, D., Mor, Y., & Sloep, P. B. (2015). Teachers' perceptions about the HANDSON MOOC: A learning Design Studio Case. In *Proceedings of the European Conference on Technology Enhanced Learning (EC-TEL)* (pp. 420–427). Springer. http://doi.org/https://doi.org/10.1007/978-3-319-24258-3_34

Teachers' perceptions about the HANDSON MOOC: A Learning Design Studio case

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Abstract. Recently, Massive Open Online Courses (MOOCs) have been proposed as relevant instruments for professional development. This paper reports on two editions of the HANDSON MOOC for teacher professional development. The MOOCs use the Learning Design Studio methodology as a pedagogical framework, the Integrated Learning Design Environment (ILDE) as the design infrastructure, and Moodle and Canvas as delivery platforms. The paper summarizes the design of both MOOCs, including the supporting technologies, and presents an analysis of the evolution of teachers' perceived level of conform with approach and tooling. Data is collected in weekly and final surveys. The results show a general satisfactory level of conform in both MOOCs, which is especially high the last two weeks.

Keywords: Learning Design, MOOC, Continuous Professional Development

1 Introduction

The learning design field focuses on the importance of training teachers as designers that reflect on their particular learning contexts and analyse the characteristics of their learners as well as the contextual constraints and targeted learning objectives [1, 2]. As a field, learning design boasts over a decade of rich activity in research, development and practice [1]. However, despite this 'certain maturity', the lack of widespread adoption indicates that additional efforts are needed to better understand how to best develop teachers' design skills and what technological form such support should take [2, 3, 4].

This paper focuses on the design and tools used for a Continuous Professional Development (CPD) [4, 5] action-based learning design approach. The action is framed in the HANDSON project (http://handsonict.eu/). Characteristic of the case is that it uses a Massive Open Online Course (MOOC) to support teachers' professional development in the use of ICT in class. Using MOOCs for professional development is a growing trend [6, 7]. This also applies to the professional development of teachers, particularly relating to their ICT skills [7, 8]. HANDSON MOOC's activities follow the Learning Design Studio (LDS) methodology [9]. The LDS methodology leads participants through a design inquiry cycle in which they identify an educational challenge, investigate the context in which it is situated and the relevant pedagogical approaches, review examples of past innovations for inspiration, conceptualise a solution, prototype and evaluate it, and reflect on the process and its outcomes. Two pilots of the MOOC have been delivered using different MOOC platforms and the Integrated Learning Design Environment (ILDE) as the tool supporting the design activities [10], developed in METIS project (http://www.metis-project.org). Section 2 describes the MOOC, listing the LDS activities, tools used and the implementation approach. Evaluation results are discussed in Section 3.

2 The HANDSON MOOC

The 'Learning Design Studio for ICT-based learning activities' is the title of the HANDSON MOOC. Main features characterizing the MOOC are: 1) Emphasis on a hands-on approach based on a design process that brings together educators with wide and diverse backgrounds from around the world. 2) Focus on the LDS approach to help educators design learning activities. 3) Involve facilitators with expertise in Online Learning, Creativity and Learning Design. 4) Offer an opportunity to observe and practice methods for peer review and mentoring. 5) Creation of practical artefacts that can be used by the participants in their classrooms.

To accomplish this, the HANDSON MOOC combines a set of tools to support the LDS activities. Table 1 shows a list of them organized per pilot. Differences include the usage of Moodle (1st pilot) and Canvas (2nd pilot) as the MOOC platforms, and the use of additional learning design tools in the second pilot.

Table 1. LDS activities, course and learning design tooling

Tools (2nd LDS pilot)	**Tools (1st LDS pilot)**	**Activities**	**Week**
Canvas, GHO (Google Hangout), ILDE (Dream tool)	Moodle, GHO, ILDE (open conceptualization tools)	Design Studio Journal Dream Bazaar Convergence session	Week 1
Canvas, GHO, ILDE (Persona Card, Factors and Concerns, Learning Objectives tools)	Moodle, GHO, ILDE (Persona Card, Factors and Concerns tools)	Get familiar with persona concept Create your own persona Analysing context Objective of your learning activities Revisit your dream Convergence session	Week 2
Canvas, GHO, ILDE (Heuristic Evaluation, Scenario tools)	Moodle, GHO, ILDE (Heuristic Evaluation, open conceptualization tools)	Search for other learning activities Define the heuristics Learn about scenarios Create scenario Convergence session	Week 3
Canvas, GHO, Web2.0 tools	Moodle, GHO, Web2.0 tools	Prototype your artefact Test your prototype Consolidate your prototype Convergence session	Week 4
Canvas, GHO, ILDE (Design Narrative, Comment tool)	Moodle, GHO, ILDE (Design Narrative, Comment tool)	Publish your learning activity Peer feedback Convergence session	Week 5

HANDSON MOOC chose ILDE as the environment for participants' learning design activities because its flexibility and social approach. ILDE provides a number of tools that support learning design from conceptualization to implementation, and using different representation and pedagogies [10]. The tools are provided in the context community platform where members can share and co-create learning designs. It also makes easy for MOOC facilitators to follow participants' activity. The LDS activities involved use of ILDE conceptualization tools (Dream, Persona Card, Factors & Concerns, Learning Objectives, Heuristic Evaluation, Scenario) together with additional tools for prototyping (participants were free to choose any tool).

Because the activities were based on the LDS approach, the HANDSON MOOC is a project-based course, closer to a cMOOC than an xMOOC [6]. So there were no pre-recorded video lectures. Video is used, however through Google Hangouts in order to run the convergence sessions. These were recoded and made available as OERs for public viewing. This approach provided an engaging and interactive experience for those who could attend in real time, and a reference resource for those who could not. The main characteristics of the two MOOC pilots are summarized in Table 3. The 2nd LDS pilot was accessible to a more global community of educators since participants could communicate in seven different languages. Even though all materials and interfaces were in English, the seven languages had separate discussion and peer-mentoring spaces so participants could write in the language they felt most comfortable with. ILDE was also extended with automatic language tagging for an easy management of the designs created in ILDE. To support this diversity, volunteer facilitators were recruited, trained and accompanied before and during the MOOC.

Table 2. Implementation details of the two LDS HANDSON MOOC editions

2nd LDS pilot	**1st LDS pilot**
5 weeks (Oct, 28th to Nov. 28th 2014) + 3 weeks extension	5 weeks (May 19th to Jun. 20th2014)
Bulgarian, Catalan, English, French, Greek, Slovenian, Spanish	English
Guided through rubrics and with the peer-review Canvas option	Not-guided, via forums and ILDE
Certificate of assistance + badges + certificate for some local groups (Catalan, Greek, Bulgarian)	Certificate of assistance +

3 Results from two HANSON MOOC pilots

3.1 Methodology

The focus of the study are the general LDS approach, the supporting technologies and the learning design tools as a mechanism to understand its probability for adoption and as indicators to assess the value of tools [11]. Data was collected by weekly surveys, which elicited specific feedback on activities completed and tools used each week and at the same time tracked the evolution of teachers' perception along the weeks. Additional global questions were included the last week and in a post-survey in the 2nd LDS pilot. The 2nd pilot used a traceability system that allows analysing and comparing the responses from participants that finished against those that did not.

3.2 Key figures and level of activity reached

Table 4 summarizes the key figures characterizing both pilots. Overall, there was more activity going on in the second pilot than in the first one, both in terms of number active participants in ILDE, the number of comments added, and especially the number of designs created. In the second pilot, the activity was also more stable as the weeks went by (e.g. 288 Design Narratives created the fifth week). All the produced designs are available in the ILDE installations for both pilots (links at http://ilde.upf.edu/about/).

Table 3. Key figures for the two pilots

	2nd LDS pilot	**1st LDS pilot**
Facilitators	2 dedicated facilitators + 32 volunteer facilitators + 1 technical support	3 dedicated facilitators + 1 technical support
Registered participants in MOOC	1690	743
Registered participants in ILDE	396	323
Designs created in ILDE	2294 (644 in Bulgarian, 455 in Catalan, 411 in English, 317 in Greek, 240 in Spanish, 153 in French, 23 in Slovenian, 51 untagged language) Week 1: 424 Dream; Week 2: 380 Persona card, 290 Factors and concerns, 298 Learning objectives; Week 3: 315 Heuristic evaluation, 296 Scenario; Week 4: N/A prototypes; Week 5: 288 Design Narrative	1472 (no differentiation of languages in this pilot) Week 1: N/A Dreams; Week 2: 199 Persona card, 152 Factors and concerns; Week 3: 124 Heuristic evaluation; Week 4: N/A prototypes; Week 5: 39 Design narrative
Comments to designs (ILDE)	889	603

3.3 Teachers' perceived comfort with the MOOC tooling

Weekly surveys included questions to assess the comfort level with the global LDS approach and the different tooling used in the two MOOC editions. Figures 1 and 2 show the evolution of teachers' ratings for the MOOC platform, ILDE, Converge sessions and Hangouts, and other ICT tools used, in each pilot. The number of participants completing the survey varied every week (see horizontal axis in figures), having higher participation the first two weeks. The data visualized in both Figures indicate similar trends in teachers' perceptions. Yet, the behaviour in the evolution of their opinions varies in both pilots. It is important to say that if we only consider the data of participants finishing the MOOC, probably more highly motivated, the observed trends in data are similar.

The impact on the comfort level with ICT tools in general unfolds differently if we look at the two pilots. The 1st pilot attracted a community of teachers initially less comfortable with ICT tools in general; though at the end their perceived level of comfort had increased it did so less than for the 2nd LDS pilot. This contrasts with the 2nd LDS pilot, in which the initial level was higher and at the end it had increased nearly 30 points. Therefore in both MOOC editions participants perceived an increase of comfort level - one of the aims of the HANDSON project - but it seems to be more effective if the comfort level is already high. Note the difference between the Moodle and Canvas MOOC platforms. The comfort level with Moodle started at a higher position at the beginning of the MOOC but finished in a lower position than Canvas. The comfort level with ILDE started at the same level for both pilots and increased more for the 2nd LDS pilot; the level of comfort at the end of the 2nd pilot reaches 90% for ILDE as the learning design environment.

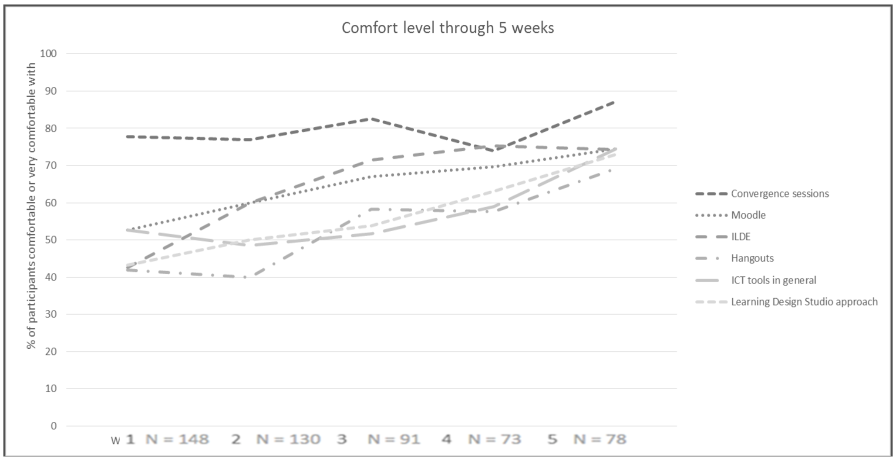

Fig. 1. Comfort (comfortable and very comfortable) with approach and tools, 1st pilot

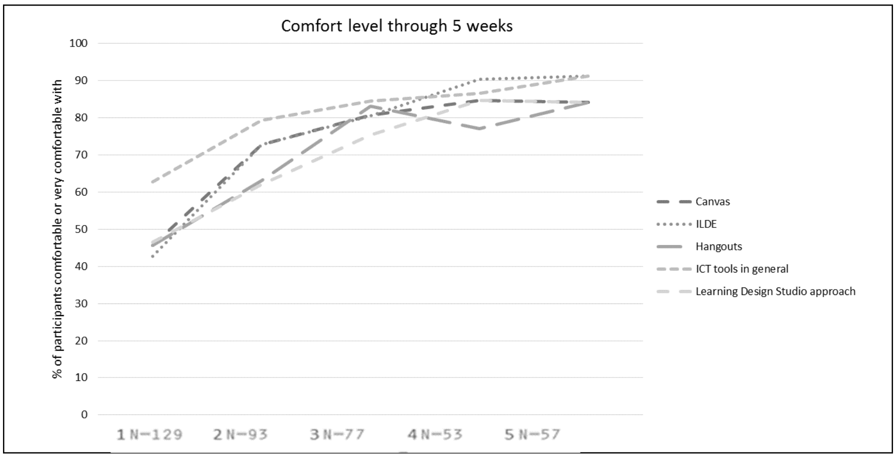

Fig. 2. Comfort (comfortable and very comfortable) with approach and tools, 2nd pilot

In both MOOC editions, the comfort level with the Learning Design Studio, as the methodology behind the proposed activities, started at a similar level - around 40% - and again increased more for participants in the 2nd pilot. This tallies with the fact that the originated activity in the 2nd LDS pilot was higher (more designs created, more comments). The post-survey used in the 2nd LDS pilot also shows this positive level of perceived usability and utility of LDS and technological support as a whole approach: 78.1% of respondents agreed with "The Learning Design Studio is a valuable resource to include ICT in education", 74.4% agreed that "The tools and templates provided to work with Learning Design Studio were appropriate" and 73.1% said that "Using Learning Design Studio can help me improve my educational practices".

4 Conclusions

This preliminary analysis of the HANDSON MOOC results show that despite the different tools used during the implementation of the course the perceived comfort levels with LDS approach and the technological setup for the MOOC delivery as well as the learning design environment (ILDE) increased, especially for the teachers participating during the second half of the MOOC and when they reached a certain familiarity with the technologies. The second edition showed that increased engagement of practitioners in learning design training can be achieved with strong facilitation, if possible in the language of the participants. A complete analysis of pre and post surveys as well as the log files from Moodle and Canvas is currently being done. These analyses will provide a deeper understanding of the MOOC impact and the type of engagement and follow-up activities that participants may need to continue with to hone the skills developed during the MOOC.

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References

1. Mor, Y., Craft, B., Hernández-Leo, D.: Editorial: The art and science of learning design. Res. Learn. Technol. 21, (2013).
2. Bennett, S., Agostinho, S., Lockyer, L.: Technology tools to support learning design: Implications derived from an investigation of university teachers' design practices. Comput. Educ. 81, 211–220 (2015).
3. Lawless, K.A., Pellegrino, J.W.: Professional Development in Integrating Technology Into Teaching and Learning: Knowns, Unknowns, and Ways to Pursue Better Questions and Answers. Rev. Educ. Res. 77, 575–614 (2007).
4. Fetter, S., Berlanga, A.J., Sloep, P.B., Vuorikari, R.: Major trends arising from the network, Tellnet deliverable 3.1., Brussels, Belgium (2011).
5. Daly, C., Pachler, N., Pelletier, C.: Continuing Professional Development in ICT for teachers. WLE Centre, Institute of Education, University of London (2009).
6. Margaryan, A., Bianco, M., Littlejohn, A.: Instructional Quality of Massive Open Online Courses (MOOCs). Comput. Educ. 80, 77–83 (2015).
7. Cross, S.: Evaluation of the OLDS MOOC curriculum design course: participant perspectives, expectations and experiences, Milton Keynes, UK (2013).
8. Laurillard, D.: Anatomy of a MOOC for Teacher CPD, Technical report. UCL Institute of Education (2014).
9. Mor, Y., Mogilevsky, O.: The learning design studio: collaborative design inquiry as teachers' professional development. Res. Learn. Technol. 21, 1–15 (2013).
10. Hernández-Leo, D., Asensio-Pérez, J.I., Derntl, M., Prieto, L.P., Chacón, J.: ILDE: Community Environment for Conceptualizing, Authoring and Deploying Learning Activities. Proceedings of the 9th European Conference on Technology Enhanced Learning. LNCS, vol. 8719, pp. 490-493. Springer, Heidelberg (2014)
11. Venkatesh, V., Morris, M., Davis, G., Davis, F.: User Acceptance of Information Technology: Toward a Unified View. MIS Q. 27, 425–478 (2003).

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Education, Technology and Design: A much needed interdisciplinary collaboration

Muriel Garreta-Domingo, Davinia Hernández-Leo and Peter B. Sloep

Abstract

In this chapter we defend and underpin our claim that, to improve and innovate education, a novel conception of the role of design in education is needed. What this conception is we will elaborate on, specifically on how it affects design in education as it is customarily practiced. We will apply this conception in the context of technology-enhanced learning (TEL). Because of its potential to have an impact on education, TEL more than any other form of learning demands consciously devised learning designs. Thus, our proposal addresses both the design of learning, in particular learning activities, and the design of educational technology. We focus on human-centred design (HCD), a problem-solving framework underpinned by user involvement in all stages of the process. HCD provides professional designers with a mindset and a toolbox that includes both process and methods. It is multidisciplinary by default and also practice-oriented, context-aware, empathetic and incremental. As such it naturally fits many of educators' everyday realities. Leveraging human-centred design theories and practices will greatly benefit educational design and give it the push it has been missing, we argue. Our proposal focuses on how HCD can enhance and facilitate technology-enhanced learning by 1) focussing on the design of learning activities, 2) involving all its actors in a timely and meaningful way; and 3) affecting its micro, meso and macro levels.

Introduction

The notion that education 'lives' in a designed environment hardly becomes apparent in the classroom or lecture room. Although in the early days of the industrial revolution, lecturing (instead of one-on-one teaching) was invented, it now is so much part and parcel of our everyday experience we barely notice education's designed character anymore (Bates 2015). The advent of technology-enhanced learning changed that, for now conscious decisions had to be made on what technologies to include and how to apply them. However, there is a tendency to shun innovations through the application of learning technologies, in particular those that may disrupt existing practice (Flavin and Quintero 2018). In our view this results from a lack of conscious acknowledgement that teaching and learning are essentially designed activities. By focussing on technology-

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enhanced learning, we aim to show how a conscious design stance may improve education and indeed educational technology as well.

Whereas most physical classrooms layouts and models resemble those of decades ago, the tasks of educators have been deeply affected by the changes in society. We might still encounter that odd educator who just uses a paper textbook for her teaching or keeps using the same written notes year after year to address her students. However, such educators now can only be the exception as the pressure from society on education is mounting and the adoption of technology has become unavoidable. It is our conviction that this push towards change in education - not only incremental but also disruptive - has mostly been done without adequate support. Instead, educators are being asked to take on so many more roles representing equally many different specialities that it is impossible for them - as individuals - to master them all.

Psychologist, conflict mediator, actor, counsellor, coach, technologist, diversity expert, individual empowerment expert, and many other "hats" are pushed on educators. Networked learning is even pushing on more hats, as authors have identified roles such as "the collector", "the curator", "the alchemist", "the programmer", "the concierge", to mention just a few of them (Downes 2010; Siemens 2008). These many roles have then to be interpreted within an increasingly complex classroom orchestration (Dillenbourg 2011), that includes a number of tools and meso and macro levels requirements. Our claim is that this constant push to bring change through the micro-level of the teacher is unrealistic.

Technology is sometimes seen to form the core of online learning, a complement in blended learning and tangential to face-to-face learning. However, this is hardly true anymore, technology is pervasive and its effects are expansive: technology is a constant part of the lives of educators and students; whether it has an "educational" origin or not. Thus, questions such as which technology to incorporate, how to integrate it, when to deploy it, how to assess the results, and what to do next, call for conscious decisions. Such decisions are seldom made (Kirkwood and Price 2014). To remedy this situation we suggest that the integration of technology in education needs to be 'designed' from the ground up, with the support of experts from other disciplines, but with educators leading these design tasks. Furthermore, a human-centred design approach will make a key difference to such design efforts.

Thus, our focus is on the activity of designing technology-enhanced learning. Admittedly, this is also the focus of the Learning Design field (Dalziel et al. 2012; Laurillard 2012), but the term wrongly suggest that learning can be designed. At best the conditions for it can (see also Carvalho and Goodyear 2014; Goodyear 2015). This notwithstanding, we conceptualize Learning Design as a specialisation of human-centred design. Matching the goals of Learning Design, we believe that human-centred design can bring more coherence to the current, rather loosely organised and individually-oriented task of design for learning with Information and Communication Technologies (ICT) tools. To accomplish this, three intertwined aspects need to be addressed: 1) how to incorporate the human-centred design *mindset* in the design of technology-enhanced learning, 2) how to bring the human-centred design *process* in the design of ICT-based activities and educational technology, and 3) how to bring in human-centred design *methods* to the design for learning.

The present chapter elaborates on these three aspects. It is structured as follows. We start with an overview of the two key ingredients of our argument: human-centred design as well as current trends in technology-enhanced learning. Then follows a survey of what is known of educators as designers and an overview of a real intervention that was aimed to guide educators through the design of an ICT-based learning activity. Drawing on our desk research and our own experiences with said intervention, we conclude with a proposal on how, through the incorporation of human-centred design, teams could design more relevant technology-enhanced learning.

An exploration of Human-Centred Design and Technology-Enhanced Learning

Many educators pride themselves on being pedagogically (as opposed to technologically) driven in their teaching and learning designs (Anderson and Dron 2011). Without delving into the many possible reasons, we do acknowledge that there are still tensions when it comes to incorporating technology in education. Terry Anderson (2009) uses the metaphor of a *dance* to explain how technology and pedagogy intertwine: technology sets the beat and creates the music, while pedagogy defines the moves. Pursuing this metaphor, we can view Jonassen and Reeves' categories (1996) of how students interact with technologies as three different types of dances, scripted by educators. Their categorial system differentiates between *learning about technology* (technology as a subject), *learning from technology* (technology as a delivery tool) and *learning with technology* (technology as a cognitive partner). When we described earlier the use of technology in education as either incremental or disruptive, it is only the third option – technology as a cognitive partner - that holds promises for innovation; whether incremental or disruptive.

Human-Centred Design

With Herbert Simon, we believe that design is a problem-solving, process-oriented activity and we subscribe to his idea that: "everyone designs who devises courses of action aimed at changing existing situations into preferred ones" (Simon 1996, p. 111). This quote captures the essence of our point of view: not only designers design but everyone does at some point of time. Nevertheless, we also consider design to be a specialist undertaking. As such, its results profit from a specific mindset, a set of methods and a defined process.

As we already announced our theoretical approach is aligned with the notion of human-centred design (HCD), as it provides this specific mindset, toolbox of methods, and process. Some of these are clearly defined by the six key *principles* that guide the implementation of HCD from the ISO 9241-210 'Ergonomics of human-centred system interaction' (ISO 2009):

1. the design should be based upon an explicit understanding of users, tasks, and environments;

2. users should be involved throughout the design;
3. the design should be driven by user-centred evaluation;
4. the process should be iterative;
5. the design should address the whole user experience; and
6. the design team should be multidisciplinary in terms of skills and perspectives.

We strongly believe that these principles should also guide the conceptualization, implementation, integration and refinement of technology-enhanced learning and educational technology.

As per the first principle, HCD is a design philosophy that incorporates the end user's' perspective at each step of the product or service development. This way both the design process and its results become humanized in a two-way process of information exchange (Norman 2013; Cooper 2004). This is linked with the concept of iteration (principle 4) and fits with current HCD developments such as the idea of "sense & respond" (Gothelf and Seiden 2017), which we will explain later. Crucially, humans are a prominent part of the equation and so we also embrace a bidirectional relationship between users and designers.

In education, there are two main groups of users: educators and students. Note, however, that our focus lies with the meta-level of the design of learning. That is, we do not focus on how learning design affects the learners but rather on the question of how to support educators in their design activities. In our view, the realm of the design for learning - that is, the design of technology-enhanced learning activities - ought to be governed by educators. Thus, in this layered environment that is education, educators are our key target users. Educators - forming education's micro-level - also become the "bridge" with other stakeholders - such as learning technologists or instructional designers - who contribute to the creation of technology-enhanced learning activities and educational technologies *per se*.

In a HCD process, users are continuously involved in service or product development (principle 2). The ways in which this is done vary depending on the development stage and of course the resources available, both in time and budget. It is key to define evaluative “checkpoints” in order to integrate the users’ feedback into the development of the designs (principle 3). This evaluation process also needs to be designed: how will the integration of that specific ICT tool be assessed? Which inputs will the educator use to decide what to do next?

The fifth principle demands that the effects and, thus, the evaluation of technology-enhanced learning be analysed at the system level. It is not just the tool per se that counts but also how it supports the learning activity, how it is perceived and grasped by the students, how the educator can follow what is going on, etc. The field of Teachers Inquiry into Student Learning (TISL) (Wasson et al. 2016) promotes the idea that the usage of student data is a skill that teachers must develop in order to teach in the information and technology-rich classroom (data literacy).

This proposal, however, takes us back to our previous claim: individual educators themselves cannot be expected to master and orchestrate the increasingly complex and diverse array of tools, resources, activities, data and people that make up learning ecosystems. This is why, distancing ourselves from fields such as TISL or Teachers as Designers (Kali et al. 2015), we bring in principle 6: educators should be surrounded by multi-disciplinary teams in terms of skills and perspectives.

To sum up our design stance, we adopt human-centred design as our lens and baseline because:

1. It is a mindset, one that entails a specific and guided approach to problem-solving.
2. It acknowledges the role of humans both as designers and users of design processes, services and artefacts.
3. It is system-aware, it does not take technology or the users out of their context. It concerns itself with the many forces that interact and collide.
4. It is process-oriented and provides a set of methods to address design as a continuous activity based on learning from and improvement of the designed artefacts.

These characteristics, we propose, should provide the guiding principles for the processes of conceptualization, implementation, evaluation and improvement of technology-enhanced learning. Although the design stance we advocate does not restrict its use to technology-enhanced learning contexts in education, it best shows its strength there.

With the growing intricacy and pervasiveness of technology, human-centred design has evolved and branched off into different fields; in spite of their different approaches and names, they all share a focus on the end user of a product or service. Thus, whether one calls it "user experience" (UX), "design thinking", "service design" or "lean UX", all are still following the same human-centred design principles.

Whereas in academia, human-computer interaction is the common term for the same concept, user experience (UX) (Kuniavsky 2003) is the most widespread name in the industry and less formal training settings. Design thinking (Buchanan 1992, to cite just one) is also well-known and promotes an empathic, empirical and iterative approach, again very similar to human-centred design.

Service design (Stickdorn and Schneider 2012) openly acknowledged the idea that user experience is holistic and encompasses all moments and levels of a user interacting with a service and not just with the product itself. Thus, the design needs to encompass people, infrastructure, communication and material components of a service. Carvalho and Goodyear (2017) advocate the application of service design ideas and methods in the realm of education since "design for learning is hybrid, involving mixtures of service, product and space design. This hybridity is accompanied by a need for a more complex knowledge-base for design than is sometimes found in discussions of knowledge for university teaching" (Goodyear 2015).

The design of technology-enhanced learning should not only learn from service design but also incorporate more "agile" and novel approaches which - again based on the same HCD principles - call for faster cycles of design to constantly learn from users and, thus, reduce uncertainty (Gothelf and Seiden 2017). As is characteristic of the social realm, educators cannot know beforehand the impact and effects that a given learning activity will have. The Lean UX approach focuses on how to learn about this impact as early as possible to make the necessary adjustments to the designed service or product.

In Lean UX (Gothelf and Seiden 2016) as in the Lean Startup movement (Ries 2011), the design cycles consist of three phases: learn, build and measure. The main difference with HCD - besides the focus on short cycles - is that the process starts with a solution (normally called a 'Minimum Viable Product') as opposed to an initial period of investigating the target users. The goal of the minimum viable product is to put the product in the hands of users as soon as possible to gather feedback and improve subsequent product iterations.

Thus, as Gothelf and Seiden (2017) state, any company needs to establish a continuous conversation with its users in order to learn from them and include these learnings in the product development. This approach also involves a shift in focus: instead of working to get "outputs", teams should aim to get "outcomes". This is best done through cross-functional and autonomous teams, whose main goal is to learn about the interaction between the users and the designed product or service. These newer HCD approaches have also incorporated the scientific method to guide the validation of assumptions and hypotheses, all aimed at reducing uncertainty.

There have been attempts to strengthen collaboration and combine perspectives of designers, educators and educational technologists, but research on how to organize this is still limited. Researchers have tested the integration of educators in the design processes: research for practice (Shrader et al. 2001); design-based implementation research (Penuel et al. 2011); teachers as collaborative designers (Cviko et al. 2014; Svihla et al. 2015; Voogt et al. 2015); teachers as participatory designers (Cober et al. 2015); or through partnerships (Matuk et al. 2015). Although these initiatives go a long way, they still fail to properly empower educators.

Technology-Enhanced Learning (TEL)

Within technology-enhanced learning, *technology as a delivery tool* is the mainstream mode of adoption of educational technology nowadays. However, *technology as a cognitive partner* is what we strive for. This is true for both educational researchers (Jonassen and Reeves 1996; Ertmer and Ottenbreit-Leftwich 2012; Ertmer et al. 2012) and educational technologists (Brown et al. 2015; Merriman et al. 2016; Dron and Anderson 2016). Thus, these often siloed and tensioned disciplines seem to have a common goal: integrate technology to allow students to do real work and, therefore, facilitate authentic student learning (see also Sloep 2013).

With this aim in mind, several institutions have already worked on the development of post-Learning Management Systems (LMS) solutions. This is the case of the OUNL and Athabasca University, for example. The former, under the name of OpenU, has created a learning system with four distinct environments: the Personal Learning Network, the Course Learning Network; the Professional Development Network and the topic/research networks (Hermans et al. 2013). Similarly, to support the need for social learning, Athabasca University has developed the "Athabasca Landing", an Elgg-based beyond-the-LMS social system (Rahman and Dron 2012). These solutions are part of what Anderson and Dron (Anderson and Dron 2011; Dron and Anderson 2016) define as the "fourth or holistic generation" of educational technology; one that will be deeply integrated within learners' whole lives and those of others.

These new environments respond to the increasing unease with existing LMSs (Kop and Fournier 2013) and the need for more social-oriented, not course-limited environments. About ten years ago, the limitations and constraints of mainstream LMSs gave birth to the Personal Learning Environments (PLEs) concept (Wilson et al. 2007). Whereas the LMS is built around the course concept and intended for formal instruction in particular, the idea behind the Personal Learning Environment is that it is governed solely by the learner. Essentially, PLEs aim to facilitate students' use of technology as a cognitive partner (Rajagopal et al. 2017).

The current state of the TEL art is that there are a myriad of technology tools and devices that currently support technology-enhanced learning, which can be integrated through a “Lego-approach”, already foreseen in the PLE literature and now apparent in the Next Generation of Digital Learning Environments (NGDLE) reports (Table 1). This next generation is closer to a learning ecosystem: a learning environment consisting of learning tools and components that adhere to common standards and enable different and diverse pedagogies.

Table 1. *Characteristics of the next generation of digital learning environments*

The NDGLE: A component infrastructure to leverage technology for teaching and learning	
The Next Generation Digital Learning Environment: A Report on Research - EDUCAUSE 2015 (Brown et al. 2015)	Next-generation environments must address five dimensions: interoperability and integration; personalization; analytics, advising, and learning assessment; collaboration and accessibility and universal design.
The Next Generation Learning Architecture - (Merriman et al. 2016)	The next generation of digital learning environments consists of a marketplace of Enterprise Infrastructure Services and a marketplace of educational applications, of various types or classes, which consume Enterprise Infrastructure Services. A new class of applications, the Learning Method eXperience (LMX) provides the context and overall user experience required for a particular educational methodology or pedagogical model.
Educational Provisioning System (EPS) - (Hermans et al. 2015)	Rather than implementing provisioning rules directly in an online learning system, the EPS allows for managing provisioning rules independent of the learning application(s) in use. This EPS allows for both managing and processing provisioning rules in order to meet the demands of new online educational formats.

This flexibility, disaggregation, modularity, Lego-structure of the upcoming educational-technology environments is extremely challenging from the designers’ and users’ perspectives since it places the focus on their activities. The underlying characteristic of NGDLE is that learners and educators will be able to shape and customize their learning environments to support their needs and objectives. Yet, still most educational technology is developed without the inputs from educators or educational sciences (Könings et al. 2007; Könings et al. 2014).

On the other hand, due to its component-based architecture grounded in standards and best practices, the NGDLE brings the opportunity to explore new approaches and develop new tools. The success of these learning ecosystems is highly dependant on the processes and activities that actually involve learning science knowledge as well as educators (and at a later stage, students) in the conceptualization and refinement of the educational technologies' features. Without this involvement, *learning* will still not be part of the environment and it will be yet another technology limited to the status of delivery tool at best.

As a result, technology-enhanced learning is at a paradoxical stage. On the one hand, practitioners of all related disciplines - educational researchers, educators, learning technologists - agree on the essentials: 1) learning with technology has yet to mature; 2) technology in education should become a cognitive tool. On the other hand, the means to make this happen have not yet been established.

Our proposal is that HCD provides these means to purposely implement TEL and impact the three levels of learning and teaching - micro, meso and macro. HCD will facilitate the "conversations" between these levels and related stakeholders by providing, first of all, a shared mindset: all work for the end users' (students') needs; and secondly, by establishing a process and the tools that allow one to integrate these needs and context into TEL designs and also the educational technology involved.

In fact, following the NGDLE metaphor of Lego pieces, our approach also puts into play the human pieces. Only with an interplay of disciplines will education include technology as a cognitive tool, will educational technology be designed for its users, and will learning environments be designed for learning. We will do so by screening off a precious yet battered resource: educators. Then, we will see the same evolution as professional designers will soon have to embrace (Manzini 2015; Sanders 2006):

both educators and designers will be *enablers*, facilitators and process managers for others to learn and design, respectively.

Educators as designers

In the HCD sense, educators are our target users. They are ultimately responsible for the design, enactment and development of TEL activities. They also liaise with their students and with the educational institution they work for. Thus, their role is pivotal in any effort to incorporate the HCD mindset, process and methods in education.

We start by providing an overview of what is known of how educators design and then we introduce the results of an intervention. It was designed to guide educators through a HCD process which was meant to facilitate educators to design technology-enhanced learning activities.

Teachers as designers, what we know

By now it should not come as a surprise that we claim designing to be a complex and intricate task. It demands of the designer to take into account and integrate many different and diverse elements. It also requires her to consider the problem and the solution from many different perspectives. This description of design deeply resonates with an educator's work. Teachers must perceive, interpret and enact existing resources, evaluate the constraints of the classroom setting, balance trade-offs and devise strategies – all in the pursuit of their instructional goals (Brown and Edelson 2003). As in design, educators create, adapt and try out resources to fit their specific needs and contexts.

Many researchers such as Brown and Edelson (2003) emphasize this situated and practice-oriented design work that educators accomplish. This pragmatic approach to design means that educators privilege practicality and feasibility (McKenney et al. 2015) and leverage practice-based experiences to make decisions (Roschelle and Penuel 2006). As a result, much relevant teacher design expertise comes intuitively, is acquired on a daily basis and congruent with the teacher's beliefs and convictions.

Schön (1983) defined this kind of intuited expertise as "designerly ways of knowing", which are learned through direct and indirect engagement in authentic design practices, rather than an explicit, formally-represented body of knowledge and skills. According to Schön, professionalism is gained by *reflection-in-action*, which enables the practitioner to think deeply about situations while they are happening, interpret and frame them in particular ways and adapt his/her actions accordingly, as opposed to *reflection-on-action*, which is done after the fact, much as an afterthought.

Extending the research on how educators actually design, according to Matuk et al. (2015) teachers' decisions in customizing technology-enhanced learning materials are the result of interactions between knowledge of their students and the subject matter, beliefs about teaching and learning, and orientations toward technology and their roles as designers. The authors conclude: "Research also indicates that whereas attendance to students' ideas can result in customizations that greatly benefit learning, *issues of practicality primarily drive teachers' intuitive customizations*" (italics ours).

Similarly, Bennett et al. (2015) observed that Higher Education teachers' perceptions of student characteristics, their own beliefs and experiences, and contextual factors are key influences on design decisions. In another study, Boschman et al. (2014) found that the considerations Kindergarten teachers entertained during design were influenced mostly by practical concerns, although their pedagogical orientation, beliefs about how children learn, and convictions of how learning should be supported by teachers also played a role.

So, there can be little doubt that the praxis of teachers involves design:

- As in design, teaching is a highly complex activity that draws on many kinds of knowledge (Mishra and Koehler 2006).
- As with the problem spaces in design, teaching occurs in ill-structured, dynamic environments and, therefore, teaching also deals with what are known in design as wicked problems (Rittel and Weber 1973; Opfer and Pedder 2011; Sloep 2013).

- As in design, teaching is iterative: it seldom happens just once; there is a continuous enactment and tweaking of activities and resources (Pardo et al. 2015; Bates 2015).

While we can see some patterns emerging from existing research - that we further analyse below - some authors (Agostinho et al. 2011; McKenney et al. 2015) also point out how more empirical research is needed to better understand teachers' design practices so as to achieve closer alignment between teachers' needs and their design initiatives.

However, the way in which educators design, also reveals a number of idiosyncrasies:

1. **Teacher designs are experience-shaped.** Kali et al. (2011) talk about "folk pedagogy" (in an apparent analogy to folk psychology), that is, how an individual teacher's ways of teaching are strongly shaped by his/her personal experience of having been taught themselves. Educators can discuss sophisticated ideas of instruction in the abstract, for example on how to incorporate educational technology. And yet, specific design situations activate experiential knowledge, which more often than not leads to traditional forms of instruction.
2. **Teacher designs are underpinned by beliefs.** In 1999, Ertmer (1999) distinguished between two types of barriers that impact teachers' uses of technology in the classroom:
    a. First-order barriers are defined as those that are external to the teacher and include resources (both hardware and software), training, and support.
    b. Second-order barriers comprise those that are internal to the teacher and include teachers' confidence, beliefs about how students learn, as well as the perceived value of technology to the teaching/learning process.

   Although first-order barriers pose significant obstacles to achieving technology integration, the underlying, unconscious second-order barriers have proved to pose the greater challenge (see also Kreijns et al. 2013).

3. **Teacher designs are learner-adapted.** Stark (2000) reported how educators' design decisions were strongly influenced by the perceived characteristics of their students. Bennett et al. (2015) confirm this influence and suggest that these judgements are currently reliant on recollections and impressions built up over time and through contact with students.
4. **Teacher designs are practice-driven and practice-oriented** (Doyle and Ponder 1977; Ertmer 1999; Janssen et al. 2013; Boschman et al. 2014; Matuk et al. 2015)**.** Practicality and feasibility is the key driver of educators when designing: teachers must ensure that the enactment with the students fulfils the learning outcomes and, for that reason, possible barriers have to be reduced to a minimum.
5. **Teacher designs are context-shaped.** As part of the practice-driven component but relevant to take into account as a separate factor, many authors have stated the relevance of context (Bennett et al. (2015) and McKenney et al. (2015), for example). Context needs to be understood not as the immediate physical space of the classroom but in a broader sense, as encompassing all factors and constraints impinging on the educator. These include the customary meso level of the school and the macro level of national educational policies and whatever bodies oversee and monitor the operation of schools.

From this set of factors, it is relevant to notice that almost all of them operate very much at an unconscious level, are deeply rooted in the experiences and beliefs of educators, and are grouped in what Ertmer (1999) defined as second-order barriers (Kreijns et al. 2013).

Kali et al. (2011) also explored how novices carry out design activities. They report how they exhibit a lack of Schön's reflection-in-action, which derives from experience. Using HCD terms, in their 'rush to implementation" (Goodyear 2015 p.31) novices skip two key phases of the design process: the exploration phase and the analysis/reflection phase (Hoogveld et al. 2002; O'Neill 2010). They ignore the "fuzzy front end" (Sanders and Stappers 2008) of exploration. But this is a critical phase, one that determines what is to be designed and sometimes what should not be designed; in it designers take into account considerations of many different natures. As such it is a divergent phase. Similarly, novices also often ignore the reflection phase. However, it is an essential step for continuous improvement, like learning by doing. Here too, novices fail to take the opportunity to use the enactment of the learning activities as a source for learning and enhancing their practices.

But what then is it that teachers do know and how does this knowledge affect their design activities? Teaching requires a complex set of knowledges, as illustrated by the Technological Pedagogical and Content Knowledge framework. This conceptual framework (Magnusson et al. 1999) for educational technology builds on Shulman's formulation of ''pedagogical content knowledge'' (Shulman 1986) and incorporates the role of technology in education.

The relationships between content (the actual subject matter that is to be learned and taught), pedagogy (the process and practice or methods of teaching and learning), and technology (both commonplace, like chalkboards, and advanced, such as digital computers) are complex and nuanced (Mishra & Koehler 2006). The analysis of the interplay needs to consider these components as a whole, in pairs, but also in isolation.

Here, we focus on the pedagogical knowledge only. For a teacher to have this type of knowledge she should understand how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions toward learning. As such, pedagogical knowledge requires an understanding of cognitive, social, and developmental theories of learning and how they apply to students in their classroom (Mishra and Koehler 2006). This is the type of knowledge that one expects educators to master.

Yet, many educators lack this "deep pedagogical knowledge". In the terms of Kali et al. (2011), the pedagogical knowledge of educators often takes the form of 'folk' beliefs. While it is true that educators think in terms of learning outcomes and the change they want to promote, they seldom ground their praxis in theories (Bennett et al. 2015).

This does not mean that educators are not concerned with pedagogy but that, rather than having a coherent and consistent theory of teaching and learning, teachers apply a loose collection of practice-oriented strategies, each one locally coherent, although not necessarily systematically validated. Kali et al. (2011) call this notion "pedagogical knowledge in pieces".

This "pedagogical knowledge in pieces" is adequate for the praxis of teaching. However, it hampers the systematization of learning designs and the conversation with other disciplines. It actually clashes with the idea that one has about what educators know. For an outsider, educators know about pedagogy. It is assumed that they ground their practice in validated theories of learning. This turns out not to be the case. We believe that this gap between how educators operate in actual fact and what other disciplines expect from them is at the core of many problems of the implementation of educational technology.

In summary, teachers are designers of learning, there can be little doubt about that. However, they design in an intuitive fashion, with a focus on direct educational practice, making use of an eclectic collection of pedagogical insights that are more informed by their own practice and perhaps those of others they know about than by theoretical insights. Various authors discussed in the above have argued this position. Many also have wondered how the design abilities of teachers could be improved upon. In an experimental intervention, in the guise of a Massive Online Open Course, we made an attempt to improve teachers' design abilities. We summarise our key learnings in the next section. Details on the experience and its results can be found in Garreta-Domingo et al. 2015; Garreta-Domingo et al. 2017; Garreta-Domingo et al. 2018 and Garreta-Domingo et al. *under review*.

Teachers as designers, an intervention

Earlier we introduced the notion that educators design with a particular mental model of who and what their learners are. Taking into account the characteristics of the students is key to good design; even if this raises the question of the quality of the information that educators have about their students (Bennett et al. 2015).

Research shows that teachers' student-centred beliefs tend to result in more authentic uses of technology while traditional beliefs tend to have a negative impact on the integrated use of computers (Hermans et al. 2008). And, at a broader level, Bennett et al. (2015) reported how many authors have concluded that student-focused approaches to teaching encourage deep approaches to learning, that result in high quality learning outcomes.

These beliefs not only affect the conceptualization of the learning activities but are beneficial also during their implementation and evaluation. A student-focused approach allows a teacher to be responsive to student needs and interests during the enactment of the activities (Postareff et al. 2008).

As Ertmer et al. (2012) confirm, research results suggest close alignment; that is, student-centred beliefs undergird student-centred practices (authenticity, student choice, collaboration). But despite such beliefs there are also constraints that prevent student-centred practices to blossom to the full. In fact, teachers with student-centred beliefs do not necessarily translate those beliefs into learning activities that use technology as a cognitive partner or indeed in activities that use technology at all. Educational practitioners often see technology as a burden, an imposition (Kreijns et al. 2013; OECD 2015). How come? Is education different, are educational practitioners different, or is there an issue with the way technology affects education?

To tackle these issues, we advocate a shift of focus, away from the technology and also, in some sense, away from the students. Educators and educational designers, developers and researchers should primarily focus on the design of learning activities and on how to enhance them through technology. This shift of focus has dramatic consequences. It implies designing *for use* rather than *for users* (Williams 2009). Following the Activity-Centred Design approach (Gay and Hembrooke 2004; Gifford and Enyedy 1995), designers should focus on the activity in order to deliver tools that effectively support users in real-world contexts (Norman 2005; Hoekman 2010). In the educational research realm, the Activity-Centred Analysis and Design (ACAD) framework (Goodyear and Carvalho 2014; Carvalho and Goodyear 2017) advocates the same shift.

The ACAD framework places the learning activity at the centre of the design process and differentiates between three different dimensions: epistemic, set and social (Table 2). Like HCD, the ACAD framework acknowledges the interplay of the different components in a system. It is our belief that we need this holistic perspective to build the next generation of digital learning environments and pedagogies and, as a consequence, the next generation of educators and learners (Sloep 2016).

Table 2. *Learning design dimensions according to Goodyear and Carvalho (2014) and how they were designed in our intervention*

Dimensions	Short description	Our intervention
Task structure and **epistemic design**	Epistemic design refers to the knowledge-oriented structure of a network; the activity is goal-oriented and facilitates learning and knowledge creation.	A Massive Open Online Course (MOOC) that walks educators through the design process of an ICT-based learning activity of their own making.
Structures of place and **set design**	The activity is also shaped by the physical / digital setting in which it unfolds. Thus, the relations between place, tools and activity are key to both analysis and design.	A combination of online tools chosen to provide the necessary learning and design support to the design efforts of the MOOC participants.
Organizational forms and **social design**	What people do is often influenced by the actions of other people around them, including the instructions, advice, encouragement and warnings they give. At a broader level, social norms, rules and habits tend to have an effect, even if other people are not physically around.	A set of facilitators to guide participant educators through their design processes; together with the comments and feedback from their peers. And of course the set of norms, rules, etc. that each participant brings along, which are outside of intervention control.

Despite their differentiation between these three design dimensions, Goodyear and Carvalho (2014 p. 57) emphasize the importance to carefully distinguish between what can be designed and what cannot: “We *may* be able to design the thing that is experienced, but we cannot design the experience itself” (italics theirs). The context, the tasks and the tools can be designed; however at learn time learners are likely to reconfigure what has been proposed in new ways (see also Goodyear 2015). As we have seen earlier, this difference between what a designer intends and what actually happens is acknowledged by HCD approaches. It is through a continuous and iterative approach to design that we learn and reduce uncertainty; at each iteration, the team analyses what happened and takes action according to it with the aim of improving the design for the forthcoming iteration and bringing that what happens closer to that which is intended.

Thus, to reiterate a point made earlier, to implement HCD in TEL three intertwined aspects need to be addressed: 1) how to incorporate the HCD *mindset* in the design of TEL, 2) how to bring the HCD *process* in the design of ICT-based activities and educational technology; and 3) how to bring in HCD *methods* to the design for learning. To gather insights into the relative importance of these three aspects, we designed an intervention along the lines of the ACAD model. After briefly introducing the context of our intervention, we explain next its 'set', 'social' and 'epistemic' design dimensions.

The context of our intervention is a Massive Open Online Course (MOOC) on a topic that - as we have seen - many teachers struggle with: the inclusion of ICT in education (OECD 2015). It was intended to offer a genuine professional development opportunity for educators of all educational levels (Garreta-Domingo et al. 2018; Stoyanov et al. 2014). The HANDSON MOOC - implemented under a Lifelong Learning Programme project (http://www.handsonict.eu/) - was open and free. Based on HCD methods and process, the course guided educators through the design of their own TEL activity.

The *set design* of the MOOC included Moodle, for the first edition, and Canvas, for the second one, as the course platform; Moodle / Canvas contained the syllabus, the design tasks as well as the discussion forums. The Integrated Learning Design Environment (ILDE) was the design platform on both occasions; this web platform allows communities of educational designers to co-create and share learning designs both from scratch or by using templates provided (Asensio-Pérez et al. 2017).

The MOOC's *social design* comprised interaction with facilitators and peers in the forums and through weekly synchronous sessions. The first iteration of the MOOC featured three facilitators, experts in Learning Design and HCD. The second iteration was offered in seven languages in parallel, thus there were 15 facilitators who addressed the students in their native language. These facilitators were all volunteers; they had no formal HCD expertise, but were trained to act as process managers for the participants. English was used for instructions and general communications only.

The *epistemic design* was grounded in the idea of studio-based teaching (Mor and Mogilevsky, 2013; Reimer and Douglas, 2003; Winograd, 1990). In this online studio, participants designed a TEL activity that by the end of the course was intended to be ready for enactment in their respective teaching settings. The epistemic design concerns the tasks learners (in our case, educators as lifelong learners) carry out in order to acquire new knowledge. Following our focus on human-centred design to empower educators as designers, our epistemic design mimics a HCD process from considering the user requirements, to conceptualising the solution and, then, testing it on each iteration (Figure 1).

Figure 1: The HANDSON MOOC's (2nd edition) course activities (see also Garreta-Domingo et al, *under authors' revision*).

Design Studio for ICT-based Learning Activities - HANDSON MOOC (2)

Week 1: Initiate **Learning goals:** Get acquainted with LDS and define an initial version of the educational challenge.	A1: Introduction to the Design Studio for ICT-based Learning Activities! A2: Set up your Design Studio Journal. It is a tool for you! A3: ILDE Account and Dream Bazaar A4: Peer-mentoring - your dream!
Week 2: Investigate **Learning goal:** Get acquainted and apply HCD methods for user needs analysis. Review educational challenge based on peer feedback.	A5: Get familiar with the persona concept A6: Create your own persona A7: Analyzing context, factors and concerns A8: The objectives of your ICT-based learning activity A9: Revisit your dream and update it A10: Peer-mentoring - Your personas!
Week 3: Inspire & Ideate **Learning goal:** Continue user needs analysis and shaping the learning activity. Start thinking on monitoring the experience.	A11: Define the heuristics for your design project A12: Search for existing ICT-based learning activities A13: Learn about user scenarios A14: Ideate through writing a user scenario A15: Peer-mentoring - The objectives
Week 4: Prototype **Learning goal:** Translate the results of previous tasks into a prototype and assess it with a user or peer.	A16: Prototype your artifact A17: Revisit and update your evaluation heuristics A18: Test your prototype *Advanced authoring and implementation* A19: Consolidate your prototype A20: Peer-mentoring - Consolidate your prototype
Week 5: Evaluate & Reflect **Learning goal:** Receive peer feedback on the design activity. Reflect on the course.	A21: Publish your learning activity A22: Peer-mentoring - Your learning activity A23: Your design studio report A24: Reflect and share your thoughts!

It is not the focus of the present chapter to analyse the results from these two interventions, interested readers are referred to the following papers: set design (Garreta-Domingo et al. 2015), social design (Garreta-Domingo et al. 2017), epistemic design (Garreta-Domingo et al. 2018 and Garreta-Domingo et al. *under review*). We summarize here what we learned from our including HCD in technology-enhanced learning:

1. **Incorporating the HCD *mindset* in the design of TEL**
   As "amateur" designers, participant educators showed some designerly concerns and tasks. Interestingly, more pedagogically-savvy educators tended to place the focus on the ICT-tool as opposed to the activity; but educators with little familiarity with pedagogical models and trends, were able to act according the to HCD mindset that was "transmitted" to them through the design tasks (epistemic design) and in the conversations in the forums (social design).
2. **Including the HCD *process* in the design of ICT-based activities and educational technology**
   Our intervention also aimed at solving several of the shortcomings that many professional development activities have: our focus was not on the theory or the technology but on a personal educational challenge that each educator wanted to address through the design of an ICT-based learning activity. This made the process much more relevant and meaningful to each participant and, therefore, useful for the desired outcome: to have an activity ready to implement.
3. **Including HCD *methods* in the design for learning?**
   Participant educators had a hard time comprehending and actioning some of the HCD methods. The general trend was to assimilate the method to what was already known to them. Thus, we see how many "personas" were just a description of a real student rather than archetypical ones, and how many "heuristics" were turned into student evaluation rubrics rather than means to evaluate their design.

Taking Carvalho and Goodyear's (2017) service design lens to analyse the insights we gained from the intervention, at the base level of learning (what educators did according to themselves) our interventions were valued very positively and participants would both repeat and recommend the experience (Garreta-Domingo et al. 2015). Nevertheless, at the superposed level of managing their own learning, participating educators did not have the necessary context nor the scaffolding to understand what was expected from them in the case of some HCD methods. We concluded that more introductory tasks as well as a less domain-specific vocabulary would facilitate the of HCD to educators (Garreta-Domingo et al. *under authors' revision*). Moreover, in line with HCD, educators should be able to practice this new framework as an iterative, in-context and applied activity.

Conclusions: Empowering educators as designers and team members

This chapter has explored the design as undertaken by teachers through the juxtaposition of human-centred design and technology-enhanced learning. The relevance of design for education is widely acknowledged. However, in line with the key ideas of HCD, our position stands out in that we emphasize that only *through its related mindset, processes and methods* design can play a key role in the creation of learning activities and of educational technology. We believe that only then design can integrate currently scattered but strongly interrelated activities. What does this imply for teachers?

Traditionally, educators have worked almost always singly. Admittedly, they have to follow curriculum programmes and abide by both educational and institutional guidelines. However, they have mostly operated on their own in their daily practices. Moreover, the traditional tensions between education and technology are still present. Still many educators and educational researchers pride themselves on being pedagogically (as opposed to technologically) driven in their teaching and learning research and designs. Still most educational technology is developed without sufficient inputs from educators or educational sciences.

We have seen how educators approach the design of learning activities and lesson plans. Their practice-oriented, experience-based and mostly intuitive design activities call for a more systematic and professional approach. We have also seen how properly designed interventions can empower teachers as HCD designers. Our empirical research has provided insights in how educators can acquire a design mindset, follow a design process and apply HCD methods, albeit that they need support through an applied learning process.

So, our answer to the question '*how can HCD bring coherence to the currently loosely organised and individually-oriented task of design for learning with ICT tools?'* would be the following. Given that educators accomplish design tasks almost on a daily basis, they could - like many designers - benefit from a hands-on, multidisciplinary, collaborative and iterative approach, as advocated by the field of human-centred design. In fact, all actors in technology-enhanced learning design would benefit from such an approach. They may not approach design in the same way, some may not even call it design, but willy-nilly they all abide by Simon's (1996) maxim to *devise courses of action aimed at changing existing situations into preferred ones*.

That said, the design of technology-enhanced learning activities is strongly related to the affordances and features of (educational) technologies. Some, erroneously, still claim technology to be 'just a tool'; but technologies also influence and define their usage, something which is even more relevant if one wants these tools to become cognitive tools. The near future holds promises: thanks to the flexibility, interoperability and distributed nature of the next generation of digital learning environments any learning design could be supported. For this to happen, we first need to design them. The foreseen software architecture allows for a Lego approach, but *someone* needs to decide which are the bricks and how they are to be put together.

As advocated by a human-centred design approach, this *someone* should be a multidisciplinary team. We cannot expect a single individual to master all components, that is, expect teachers to be jacks of all trade. It is the hands-on collaboration among disciplines that will allow for qualitatively high ranking and innovative learning designs, pedagogies and technologies. Educators, instructional designers and educational technologists need to find a common language and common processes. Heeding the maxims of human-centred design will facilitate the emergence of genuine technology-enhanced learning.

We envision, then, how a human-centred design approach will not only impact the design for learning but also the design of educational technology. The learning ecosystem is expected to be in continuous evolution and it is up to the *learning* processes and activities to guide this development. Educators, designers and technologists need to leverage data-driven (qualitative and quantitative) approaches to enhance, inform and intertwine their design spaces.

Indeed, looking further forward we see how the design for learning and the design of educational technology go hand in hand. To make this become a reality, silos need to be broken down and all actors involved need to embrace multidisciplinarity. This can only be achieved if processes, tools and language are shared. It is our belief that human-centred design as a philosophy and process facilitates these two essential changes.

Multidisciplinarity is a cornerstone of HCD in all its different representations and evolutions. For example, the idea of “sense & respond” (based on the Lean startup and Lean UX approaches, as discussed) is based on the existence of small and autonomous teams that have the capacity to learn - build - measure, thanks to a constant “conversation” with users.

Let’s then imagine a scenario, one in which cross-functional teams define the design of technology-enhanced learning as well of educational technologies. The educator is the expert on her topic as well as on the classroom orchestration, but she works closely with expert instructional designers, UX designers and educational technology developers. The instructional designers contribute their expertise as pedagogical models. The UX designers are process facilitators, design enablers; they know the methods and they ensure that the user involvement is present at all project stages, they ensure a good user experience by having a holistic view of the different elements at play. The educational technologists are the experts on ICT tools or on the next generation digital learning environment; they are key in making the necessary changes in the technology.

These self-contained teams operate at a micro-level. For them to be successful, a shared mindset and common language, processes and tools are needed. HCD is an iterative process; through complete design lifecycles, solutions are conceptualized, defined, tested and improved. These lifecycles vary in complexity and length. In a lean UX setting, the cycles are fast, we need to learn - build - measure in short periods of time because we're also working in self-contained problems. In a more traditional HCD process, the problems we address have a larger scope and weeks become months. In both cases, the results of the design lifecycles percolate through at the meso-level and progressively the same process, methods and mindset is applied for institution-wide aspects. And this, in turn, impacts the macro-level.

We can also expect another outcome to result from applying human-centred learning design with technology. Through the HCD processes and activities, teachers will learn differently and from these new collaborative, hands-on and iterative experiences they will be able to design new learning activities. As we have seen, educators design based on their beliefs and experiences and tend to fail in the initial and final analysis stages. Providing them with a context that allows them to learn differently, explore before designing and analyse the results before implementing, will have a rippling effect on their learning designs, educational technology and students. As opposed to asking them to become "jacks of all trades", educators would be surrounded by specialists that bring in new perspectives as well as empower them as the designers of learning.

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References

Agostinho, S. et al., 2011. The future of learning design. *Learning, Media & Technology*, 36(2), pp.97–99.

Anderson, T., 2009. The Dance of Technology and Pedagogy in Self-Paced Distance Education Terry Anderson, Canada Research Chair in Distance Education Athabasca University, Canada. , pp.1–7.

Anderson, T. & Dron, J., 2011. Three generations of distance education pedagogy. *International Review of Research in Open and Distance Learning*, 12(3), pp.80–97.

Asensio-Pérez, J.I. et al., 2017. Towards teaching as design: Exploring the interplay between full-lifecycle learning design tooling and Teacher Professional Development. *Computers and Education*, 114, pp.92–116.

Bates, T., 2015. *Teaching in a Digital Age: Guidelines for Designing Teaching and Learning*, Vancouver, BC: Tony Bates Associates Ltd. Available at: http://opentextbc.ca/teachinginadigitalage/.

Bennett, S., Agostinho, S. & Lockyer, L., 2015. Technology tools to support learning design: Implications derived from an investigation of university teachers' design practices. *Computers & Education*, 81, pp.211–220.

Boschman, F., McKenney, S. & Voogt, J., 2014. Understanding decision making in teachers' curriculum design approaches. *Educational Technology Research and Development*, 62(4), pp.393–416.

Brown, M., Dehoney, J. & Millichap, N., 2015. The Next Generation Digital Learning Environment: A Report on Research. , p.11.

Brown, M. & Edelson, D.C., 2003. *Teaching as design: Can we better understand the ways in which teachers use materials so we can better design materials to support their changes in practice?*, Evanston, IL.

Buchanan, R., 1992. Wicked Problems in Design Thinking. *Design Issues*, 8(2), pp.5–21.

Carvalho, L. & Goodyear, P., 2017. Design, learning networks and service innovation. *Design Studies*, pp.1–27. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0142694X17300649.

Cober, R. et al., 2015. Teachers as participatory designers: two case studies with technology-enhanced learning environments. *Instructional Science*, 43(2), pp.203–228.

Cooper, A., 2004. *The inmates are running the asylum: Why high-tech products drive us crazy and how to restore the sanity* 1st ed., Indianapolis, IN, USA: Sams - Pearson Education.

Cviko, A., McKenney, S. & Voogt, J., 2014. Teacher roles in designing technology-rich learning activities for early literacy: A cross-case analysis. *Computers and Education*, 72, pp.68–79. Available at: http://dx.doi.org/10.1016/j.compedu.2013.10.014.

Dalziel, J. et al., 2012. *The Larnaca declaration on learning design*, Available at: http://www.larnacadeclaration.org/.

Dillenbourg, P. et al., 2011. Classroom Orchestration : The Third Circle of Usability - Why is Paper Highly Usable in Classrooms ? *CSCL 2011 Proceeding*, I, pp.510–517. Available at: http://infoscience.epfl.ch/record/168741/files/Classroom Orchestration: The Third Circle of Usability.pdf?version=1.

Downes, S., 2010. The Role of the Educator. Available at: http://www.downes.ca/post/54312.

Doyle, W. & Ponder, G.A., 1977. The practicality ethic in teacher decision-making. *Interchange*, 8(3), pp.1–12.

Dron, J. & Anderson, T., 2016. The Future of E-learning. In Haythornthwaite. Caroline et al., eds. *SAGE Handbook of E-learning Research*. Sage, pp. 1–32.

Ertmer, P., 1999. Addressing first- and second-order barriers to change: strategies for technology integration. *Educational Technology Research and Development*, 47(4), pp.47–61.

Ertmer, P. & Ottenbreit-Leftwich, A.T., 2012. Removing obstacles to the pedagogical changes required by Jonassen's vision of authentic technology-enabled learning. *Computers and Education*, 64, pp.175–182. Available at: http://dx.doi.org/10.1016/j.compedu.2012.10.008.

Ertmer, P. et al., 2012. Teacher beliefs and technology integration practices: A critical relationship. *Computers and Education*, 59(2), pp.423–435. Available at: http://dx.doi.org/10.1016/j.compedu.2012.02.001.

Flavin, M. & Quintero, V., 2018. UK higher education institutions' technology-enhanced learning strategies from the perspective of disruptive innovation. *Research in Learning Technology*, 26(1063519), pp.632–637. Available at: https://journal.alt.ac.uk/index.php/rlt/article/view/1987/.

Garreta-Domingo, M. et al., 2015. Teachers' perceptions about the HANDSON MOOC: A learning Design Studio Case. In *Proceedings of the European Conference on Technology Enhanced Learning (EC-TEL)*. Springer, pp. 420–427. Available at: https://link.springer.com/chapter/10.1007%2F978-3-319-24258-3_34.

Garreta-Domingo, M., Hernández-Leo, D. & Sloep, P.B., 2018. Evaluation to support learning design: Lessons learned in a teacher training MOOC. *Australasian Journal of Educational Technology*, 33(1). Available at: https://ajet.org.au/index.php/AJET/article/view/3768.

Garreta-Domingo, M. et al., 2017. Design for collective intelligence : Pop-up communities in MOOCs. *AI & Society*, 33(1), pp.91–100.

Gay, G. & Hembrooke, H., 2004. *Activity-Centered Design: An Ecological Approach to Designing Smart Tools and Usable Systems (Acting with Technology)*, MIT Press.

Gifford, B.R. & Enyedy, N.D., 1995. Activity Centered Design : Towards a Theoretical Framework for CSCL.

Goodyear, P., 2015. Teaching as design. *HERDSA Review of Higher Education*, 2, pp.27–50. Available at: http://www.herdsa.org.au/wp-content/uploads/HERDSARHE2015v02p27.pdf.

Goodyear, P. & Carvalho, L., 2014. Framing the analysis of learning network architectures. In *The Architecture of Productive Learning Networks*. pp. 48–70.

Gothelf, J. & Seiden, J., 2016. *Lean UX: Designing Great Products with Agile Teams*, O'Reilly Media.

Gothelf, J. & Seiden, J., 2017. *Sense and Respond: How Successful Organizations Listen to Customers and Create New Products Continuously*, Harvard Business Review Press.

Hermans, H. et al., 2015. Flexible provisioning for adult learners. *Journal of Universal Computer Science*, 21(2), pp.206–222.

Hermans, H., Kalz, M. & Koper, R., 2014. Towards a learner-centred system for adult learning. *Campus-Wide Information Systems*, 31, pp.2–13.

Hermans, R. et al., 2008. The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers and Education*, 51(4), pp.1499–1509.

Hoekman, R., 2010. *Designing the Obvious: A Common Sense Approach to Web Application Design. 2nd Edition*, New Riders.

ISO, 2009. Ergonomics of human system interaction – Part 210: Human-centred design for interactive systems (ISO 9241-210:2010; formerly known as 13407). *International Organization for Standardization*.

Janssen, F. et al., 2013. How to make innovations practical. *Teachers College Record*, 115(7), pp.1–42.

Jonassen, D.H. & Reeves, Thomas, C., 1996. Learning wth technology: using computers as cognitive tools. *Handbook of Research for Educational Communications and Technology*, pp.694–719.

Kali, Y., Goodyear, P. & Markauskaite, L., 2011. Researching design practices and design cognition: contexts, experiences and pedagogical knowledge-inpieces. *Learning, Media and Technology*, 36(2), pp.129–149.

Kali, Y., McKenney, S. & Sagy, O., 2015. Teachers as designers of technology enhanced learning. *Instructional Science*, 43(2), pp.173–179.

Kirkwood, A. & Price, L., 2016. Technology-enhanced learning and teaching in higher education : what is " enhanced " and how do we know ? A critical literature review. , 9884(May), pp.1–44.

Könings, K.D., Brand-Gruwel, S. & van Merriënboer, J.J.G., 2007. Teachers' perspectives on innovations: Implications for educational design. *Teaching and Teacher Education*, 23(6), pp.985–997.

Könings, K.D., Seidel, T. & van Merriënboer, J.J.G., 2014. Participatory design of learning environments: Integrating perspectives of students, teachers, and designers. *Instructional Science*, 42(1), pp.1–9.

Kop, R. & Fournier, H., 2013. Developing a framework for research on personal learning environments. *eLearning Papers*, 35(November), pp.1–16.

Kreijns, K. et al., 2013. What stimulates teachers to integrate ICT in their pedagogical practices? the use of digital learning materials in education. *Computers in Human Behavior*, 29(1), pp.217–225.

Kuniavsky, M., 2003. *Observing the user experience: a practitioner's guide to user research* 1st ed., Morgan Kaufman Publishers, Elsevier.

Laurillard, D., 2012. *Teaching as a Design Science: Building Pedagogical Patterns for Learning and Technology*, New York and London: Routledge.

Magnusson, S., Krajcik, J. & Borko, H., 1999. Nature, sources and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman, eds. *Examining Pedagogical Content Knowledge: The construct and its implications for science education*. New York, Boston, London, Dordrecht, Moscow: Kluwer Academic Publishers, pp. 95–132.

Matuk, C.F., Linn, M.C. & Eylon, B.S., 2015. Technology to support teachers using evidence from student work to customize technology-enhanced inquiry units. *Instructional Science*, 43(2), pp.229–257.

McKenney, S. et al., 2015. Teacher design knowledge for technology enhanced learning: an ecological framework for investigating assets and needs. *Instructional Science*, 43(2), pp.181–202.

Merriman, J. et al., 2016. Next Generation Learning Architecture. Available at: http://hdl.handle.net/10609/47481.

Mishra, P. & Koehler, M.J., 2006. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), pp.1017–1054.

Mor, Y. & Mogilevsky, O., 2013. The learning design studio: collaborative design inquiry as teachers' professional development. *Research in Learning Technology*, 21(1), pp.1–15.

Norman, D.A., 2005. Human-Centered Design Considered to Be Harmful. *Interactions - Ambient intelligence: exploring our living environment*, 12(4), pp.14–19.

Norman, D.A., 2013. *The Design of Everyday Things: Revised and Expanded Edition*, Basic Books.

O'Neill, G., 2010. Initiating curriculum revision: Exploring the practices of educational developers. *International Journal for Academic Development*, 15, pp.61–71.

OECD, 2015. *Students, Computers and Learning; making the connection*,

Opfer, V.D. & Pedder, D., 2011. Conceptualizing Teacher Professional Learning. *Review of Educational Research*, 81(3), pp.376–407. Available at: http://rer.sagepub.com/cgi/doi/10.3102/0034654311413609.

Pardo, A., Ellis, R.A. & Calvo, R.A., 2015. Combining observational and experiential data to inform the redesign of learning activities. *Proceedings of the Fifth International Conference on Learning Analytics And Knowledge - LAK '15*, pp.305–309. Available at: http://dl.acm.org/citation.cfm?id=2723576.2723625.

Penuel, W.R. et al., 2011. Organizing Research and Development at the Intersection of Learning, Implementation, and Design. *Educational Researcher*, 40(7), pp.331–337.

Postareff, L. et al., 2008. Consonance and dissonance in descriptions of teaching of university teachers. *Studies in Higher Education*, 33(1), pp.49–61. Available at: http://dx.doi.org/10.1080/03075070701794809.

Rahman, N. & Dron, J., 2012. Challenges and opportunities for learning analytics when formal teaching meets social spaces. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge - LAK '12*. New York, New York, USA: ACM Press, pp. 54–58.

Rajagopal, K., Van Bruggen, J.M. & Sloep, P.B., 2017. Recommending peers for learning: Matching on dissimilarity in interpretations to provoke breakdown. *Educational Technology*, 48(2), pp.385–406.

Reimer, Y.J. & Douglas, S.A., 2003. Teaching HCI Design With the Studio Approach. *Computer Science Education*, 13(3), pp.191–205.

Ries, E., 2011. *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, Currency.

Rittel, H.W.J. & Webber, M.M., 1973. Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), pp.155–169.

Roschelle, J. & Penuel, W.R., 2006. Co-design of innovations with teachers: Definition and dynamics. *… of the 7Th International Conference on …*, pp.606–612. Available at: http://dl.acm.org/citation.cfm?id=1150122.

Sanders, E.B.-N., 2006. Scaffolds for building everyday creativity. In J. Frascara, ed. *Designing effective communications: creating contexts for clarity and meaning*. New York, New York, USA: Allworth Press, pp. 65–77.

Sanders, E.B.-N. & Stappers, P.J., 2008. Co-creation and the new landscapes of design. *CoDesign*, 4(1), pp.5–18.

Schön, D.A., 1983. *The Reflective Practitioner; How Professionals Think in Action*, USA: Basic Books.

Shrader, G. et al., 2001. Participatory design of science curricula: The case for research for practice. In *Annual Meeting of the American Educational Research Association*. Seattle, WA.

Shulman, L.S., 1986. Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher*, 15(2), pp.4–14.

Siemens, G., 2008. *Learning and Knowing in Networks: Changing roles for Educators and Designers*, Available at: http://www.academia.edu/2857165/Learning_and_knowing_in_networks_Changing_roles_for_educators_and_designers.

Simon, H.A., 1996. *The Sciences of the Artificial* 3rd ed., Cambridge, MA: MIT Press.

Sloep, P.B., 2013. Networked professional learning. In A. Littlejohn & A. Margaryan, eds. *Technology-enhanced Professional Learning: Processes, Practices and Tools*. London: Routledge, pp. 97–108. Available at: http://hdl.handle.net/1820/5215.

Stark, J.S., 2000. Planning introductory college courses: content , context and form. *Instructional Science*, 28, pp.413–438.

Stickdorn, M. & Schneider, J., 2012. *This is Service Design Thinking: Basics, Tools, Cases*, Wiley.

Stoyanov, S. et al., 2014. Teacher-training, ICT, Creativity, MOOC, Moodle - What pedagogy? In L. Gómez Chova, A. López Martínez, & I. Candel Torres, eds. *Proceedings of Edulearn 14, the Sixth International Conference on Education and New Learning Technologies (EDULEARN 14)*. Barcelona, Spain: IATED Academy, IATED Digital Library, pp. 5678–5686. Available at: http://hdl.handle.net/1820/5463.

Svihla, V. et al., 2015. A fingerprint pattern of supports for teachers' designing of technology-enhanced learning. *Instructional Science*, 43(2), pp.283–307.

Voogt, J. et al., 2015. Collaborative design as a form of professional development. *Instructional Science*, 43(2), pp.259–282.

Wasson, B., Hansen, C.J. & Netteland, G., 2016. Data Literacy and Use for Learning when using Learning Analytics for Learners. In *LAK 2016*. Edinburgh. Available at: http://ceur-ws.org/Vol-1596/paper6.pdf.

Williams, A., 2009. User-centered design, activity-centered design, and goal-directed design. *Proceedings of the 27th ACM international conference on Design of communication - SIGDOC '09*, pp.1–8.

Wilson, S., Johnson, M. & Sharples, P., 2007. Personal Learning Environments : challenging the dominant design of educational systems . *Je-LKS - Journal of e-Learning and Knowledge Society*, 3(2), pp.27–38. Available at: http://ubir.bolton.ac.uk/index.php?action=fileDownload&resourceId=289&hash=0382c207c66a9834d4390e0f2be6ed3c52e718e5&filename=iec_journalspr-9.pdf.

Winograd, T., 1990. What Can We Teach About Human-Computer Interaction. In *CHI'90 Proceedings*. New York, NY, pp. 443–449.