

## **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.

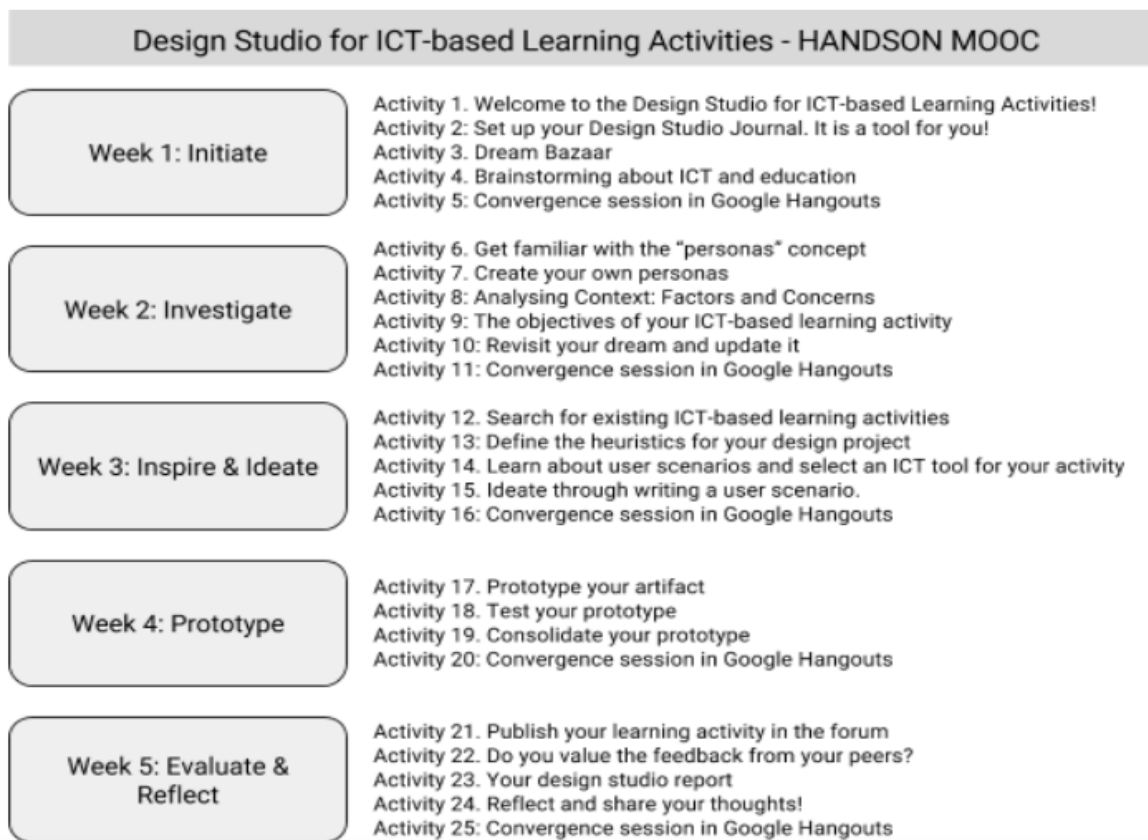


Figure 1. The HANDSON MOOC's learning tasks

### 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.

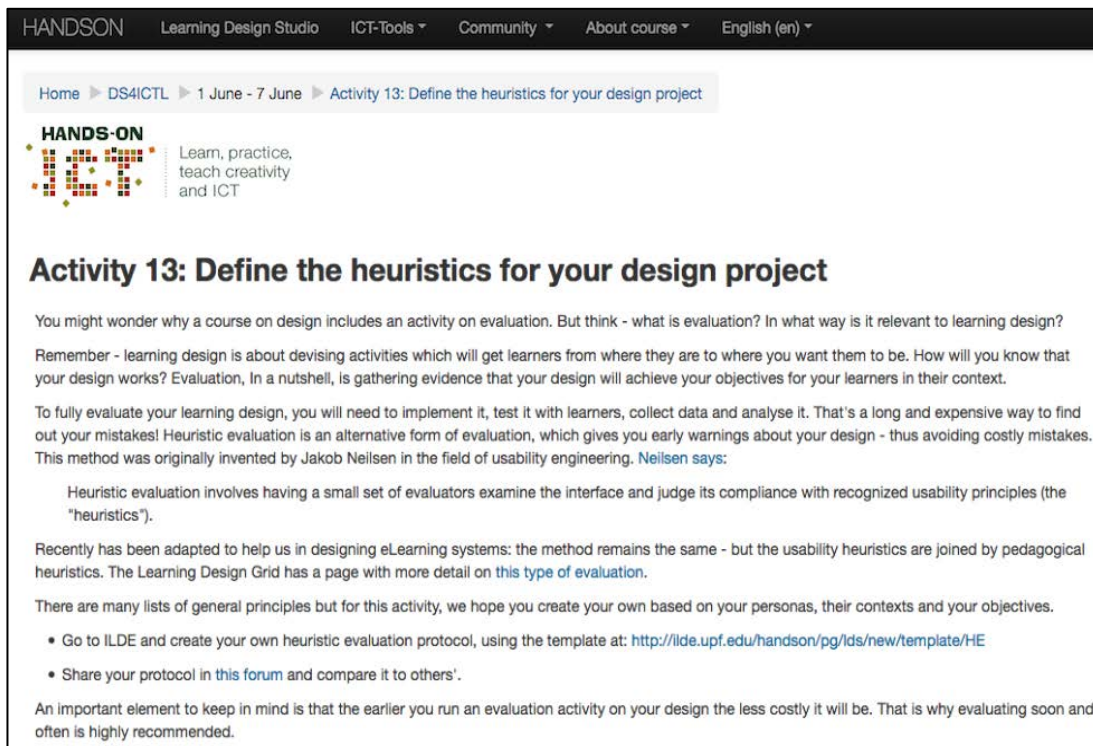


Figure 2. Screenshot from the Moodle environment

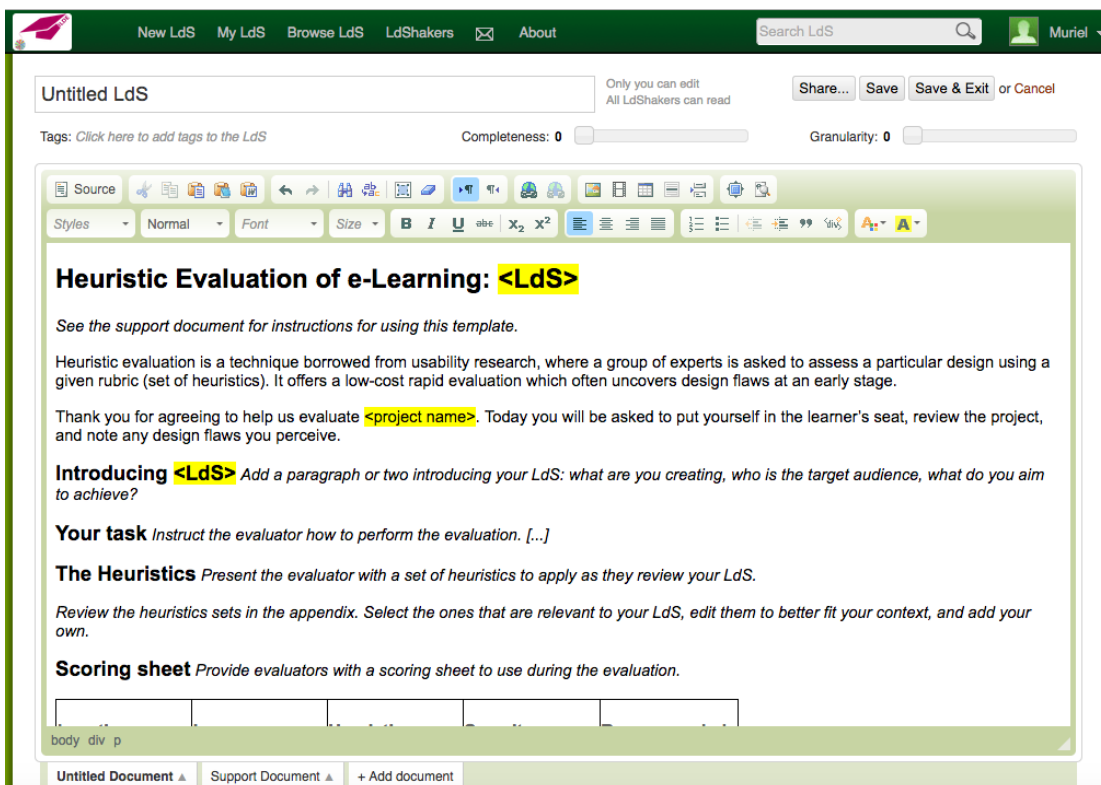


Figure 3. Heuristic evaluation template in ILDE. See <https://ilde.upf.edu/handson/v/kuf> for the complete template.

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*

<b>Set name</b>	<b>Set description</b>	<b>Example of a usability/user interface heuristic</b>	<b>Example of an educational design heuristic</b>
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.	<i>Maximises match between the system and the real world.</i> The design speaks the users' language rather than jargon. Information appears in a natural and logical order.	<i>Clear goals and objectives.</i> 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.	<i>Everyday language.</i> 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: <ul style="list-style-type: none"> <li>• General interface usability criteria (based on Nielsen &amp; Mack's (1994) heuristics, modified for e-learning context)</li> <li>• Website-specific criteria</li> <li>• Educational criteria: Learner-centred instructional design, grounded in learning theory. Each heuristic has a short statement and a small set of related statements.</li> </ul>	<p><i>Category 1: General interface usability criteria (based on Nielsen &amp; Macks's (1994) heuristics, modified for e-learning context)</i></p> <p><i>Match between the system and the real world, i.e., match between designer model and user model</i></p> <ul style="list-style-type: none"> <li>• Language usage in terms of phrases, symbols, and concepts is similar to that of users in their day-to-day environment.</li> <li>• Metaphor usage corresponds to real-world objects/concepts.</li> <li>• Information is arranged in a natural and logical order.</li> </ul>	<p><i>Category 3: Educational criteria: Learner-centred instructional design, grounded in learning theory</i></p> <p><i>Clarity of goals, objectives and outcomes</i></p> <ul style="list-style-type: none"> <li>• There are clear goals, objectives and outcomes for learning encounters.</li> <li>• The reason for inclusion of each page or document on the site is clear.</li> </ul>

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.	<i>Match between system and the real world.</i> 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.	<i>Learning design.</i> The interactions in the e-learning program have been designed in accord with sound principles of learning theory.
		<p>Sample questions to ask yourself:</p> <ul style="list-style-type: none"> <li>• 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?</li> <li>• Is the cognitive load of the interface as low as possible to enable learners to engage with the content, tasks ... as quickly as possible?</li> </ul>	<p>Sample questions to ask yourself:</p> <ul style="list-style-type: none"> <li>• Does the e-learning program provide for instructional interactions that reflect sound learning theory?</li> <li>• Does the e-learning program engage learners in tasks that are closely aligned with the learning goals and objectives?</li> <li>• Does the e-learning program inform learners of the objectives of the program and remind them of prior learning?</li> </ul>

## 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*

<b>Participant</b>	<b>Example</b>
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*

<b>Participant</b>	<b>Date of publication in forum</b>	<b>Date of update in forum</b>	<b>Views</b>	<b>Users</b>	<b>Sessions</b>	<b>Average duration</b>	<b>Returning visitors</b>
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).

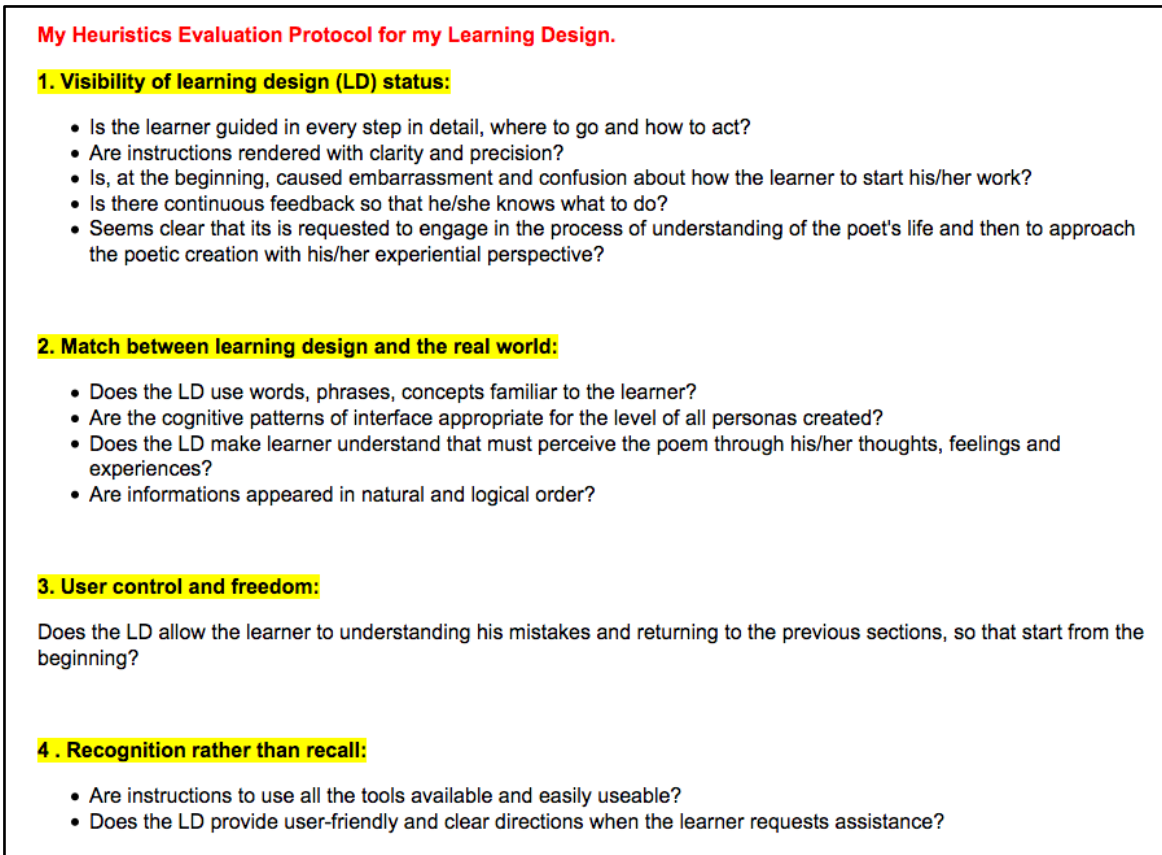


Figure 4. Heuristic protocol of P1, first heuristics from her adapted set

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.

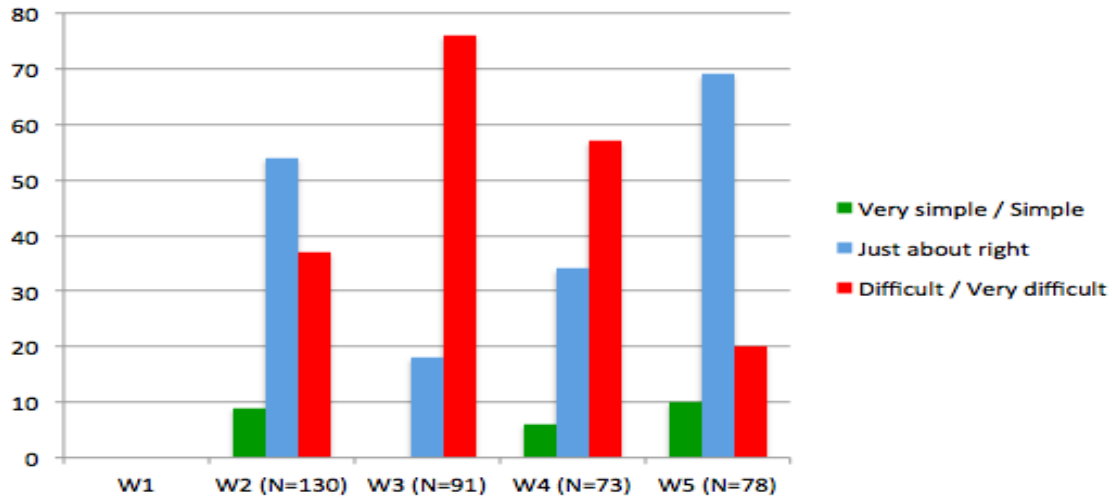


Figure 6. The level of difficulty of weekly activities, extracted from the questionnaires sent out weekly (in %)

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 theologian 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.



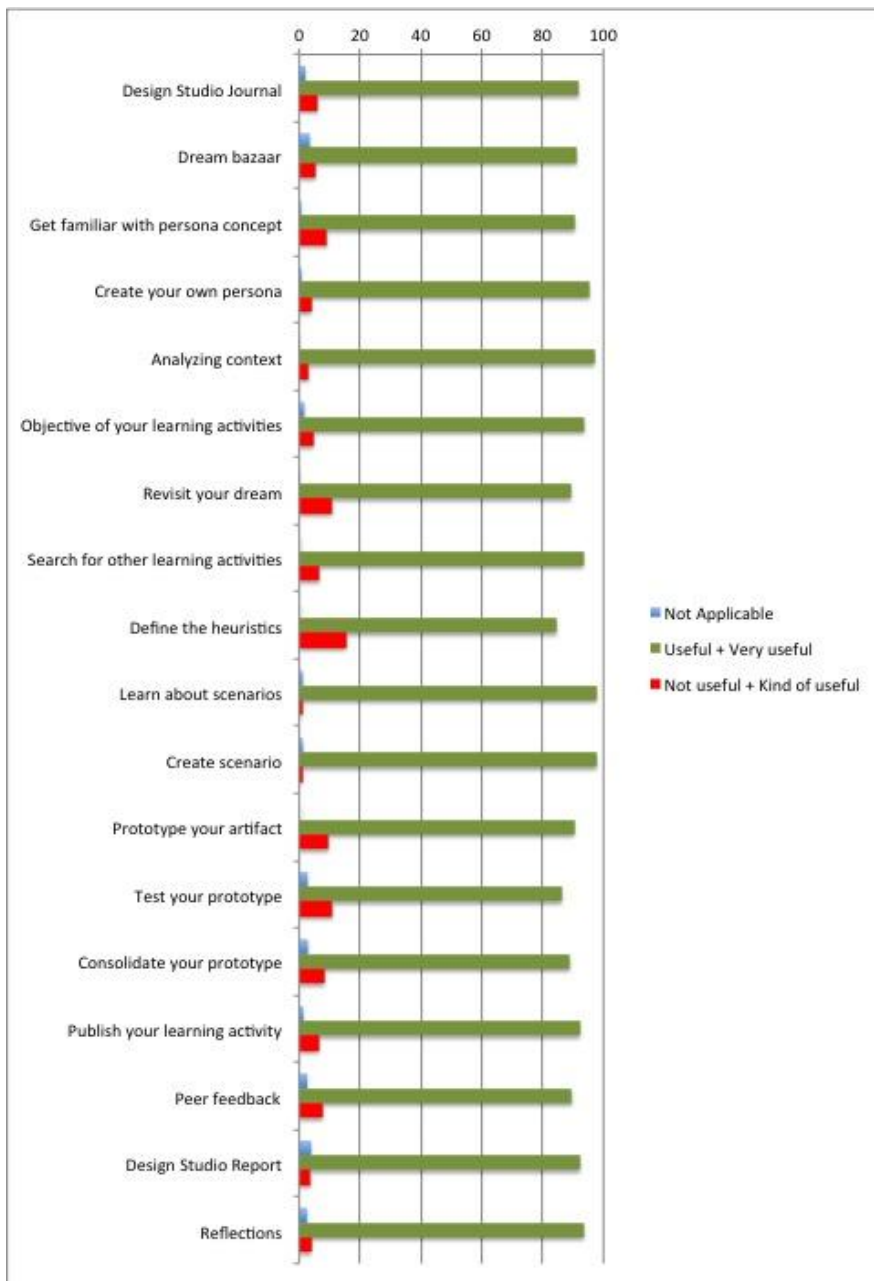


Figure 7. Answers to the level of usefulness of weekly activities (in %). Bars indicate the percentage of participants providing a score of “not applicable”, “very useful or useful”, or “not useful or kind of useful”.

## 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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