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Victoria I. Marín [ID][a], Juan I. Asensio-Pérez [ID][b], Sara Villagrá-Sobrino [ID][c], Davinia Hernández-Leo [ID][d] and Sara García-Sastre [ID][c]

[a]Department of Applied Pedagogy and Educational Psychology, Universitat de les Illes Balears, Palma, Spain; [b]Department of Signal Theory and Communications and Telematic Engineering, Universidad de Valladolid, Valladolid, Spain; [c]Department of Pedagogy, Universidad de Valladolid, Valladolid, Spain; [d]Department of Information and Communications Technologies, Universitat Pompeu i Fabra, Barcelona, Spain

ABSTRACT

This article describes a study of online collaborative design in the context of teacher professional development. Twenty-five teachers from different Spanish universities participated in the online course. The aim was to understand how to support teachers in interuniversity teams to collaborate fully online throughout the learning design process of a scenario based on their discipline integrating information and communications technology (ICT), an issue scarcely tackled in the literature. The described interpretive study, using mixed methods, explores the support of online co-design provided by a novel ICT community platform named ILDE (Integrated Learning Design Environment). Lessons drawn from the results can contribute to the improvement of online collaborative design processes in the context of teacher professional development.

Introduction

Conole (2013, p. 7) defined learning design (LD) as the 'methodology that allows teachers/designers to take informed decisions on their design of learning activities and interventions, making an effective use of resources and technologies, moving from the conceptualization of their design ideas to their implementation using a range of tools and resources'. LD fosters the role of 'Teachers as Designers' (Laurillard, 2012; McKenney, Kali, Markauskaite, & Voogt, 2015; Shamir-Inbal & Kali, 2009). On the one hand, teachers need to systematise, make explicit and share decisions about pedagogical designs (in artefacts called 'learning designs'). On the other hand, they are urged to promote reflection on their professional performance, to incorporate good practices and to improve the quality of their teaching, while creating a sense of community.

In addition to the ultimate goal of promoting 'Teaching as Design', research on LD has also focused on supporting teachers when integrating information and communications technology (ICT) with active pedagogies (Dobozy & Campbell, 2016). Consequently, several research studies have explored different approaches to the use of LD for teacher professional development (TPD) aimed at fostering ICT integration (Conole & Culver, 2009; Hernández-Leo, Moreno, Chacón, & Blat, 2014; Kali, Markauskaite, Goodyear, & Ward, 2011; Michos & Hernández-Leo, 2016; Mor & Mogilevsky, 2013; Voogt et al., 2015). LD has also recently been linked, in TPD contexts, to the importance of collaborative design of curricula (Ronen-Fuhrmann & Kali, 2015). Co-design offers opportunities for creativity, co-learning, motivation,

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engagement and development of teachers' communities of practice (Laurillard, 2012); also, co-design leads to a model of co-created and co-facilitated learning (Reilly & Literat, 2012). Furthermore, sharing practices within LD may enhance the reuse of learning scenarios, which is especially relevant if they can be shared through virtual spaces (Gros, Escofet, & Marimón-Martí, 2016). There are good examples of TPD communities in the LD field that are directed towards that aim (Conole & Culver, 2009; Michos & Hernández-Leo, 2016; Mor & Mogilevsky, 2013).

These research lines are complemented with the development of visual technological tools for LD, aimed at supporting teachers in their design processes, making easier the integration of ICT in their practice. LD processes involve a wide range of design tasks that typically go from the ideation of the learning situations (also known as 'conceptualisation') to their actual enactment using ICT tools (tasks typically referred to as 'implementation') (Pozzi, Asensio-Pérez, & Persico, 2016). Prieto et al. (2013) provided examples of LD tools supporting teachers along some or all of the phases of an LD process.

However, the previous studies have only explored the processes of co-design in specific phases of the LD lifecycle in the context of TPD, namely the conceptualisation. That is why in this study we explore the processes of interaction for consensus and support for team design in online environments through the whole lifecycle of LD, aimed at TPD for ICT integration. The study involves an online course for university teachers who participated in a co-design project, grouped according to their field of knowledge. The teachers used the Integrated Learning Design Environment (ILDE) (Hernández-Leo, Asensio-Pérez, Derntl, Prieto, & Chacón, 2014), a community environment for teachers where they can use different technological tools to (co-)create learning designs.

The research question posed was 'How to support teachers in interuniversity teams to collaborate fully online along the LD process of a discipline-based situation that integrates ICT?' Therefore, we analyse how the ILDE online co-design support helps educators reach consensus and follow a full-lifecycle design process with ICT. This study has implications both for: the whole community of teachers, regarding TPD and the support of effective technology integration in teaching practice; and LD tools developers, regarding possibilities and limitations for co-design in ILDE and developing/adapting tools that enhance co-design.

Collaborative design in TPD

One increasingly fostered form of TPD proposes teacher involvement in collaborative design of curricula (Ronen-Fuhrmann & Kali, 2015; Voogt et al., 2015). Collaboration in this context is theoretically supported mainly by a situative perspective, in which teachers can 'benefit from learning when they are actively engaged in their own learning, willing to learn from each other and the learning takes place in contexts meaningful to them' (Voogt et al., 2015, p. 269). Gros et al. (2016) stated that LD is a relevant way to guide teacher practice because it connects problems with learning solutions, creates a reusable knowledge base, encourages reflection on the learning processes and enhances knowledge transfer and learning of good practices.

Some meaningful aspects from the experiences in learning co-design for TPD can be pointed out.

- Voogt et al. (2015) identified three key features of learning in collaborative design processes: situatedness (authentic and meaningful contexts), agency and sense of ownership, and the cyclical nature of learning and change.
- Kali et al. (2011) identified four unique characteristics that make co-design processes productive: multi-dimensional exploration, balanced process, mutual respect and cross-domain expertise.
- Gros et al. (2016) combined learning co-design with an inquiry-based approach for TPD as a way of eliciting LD patterns.

All these studies focus on the conceptualisation phase and there is no evidence of the actual authoring and implementation of their learning scenarios, which would mean the necessary direct connection to the teaching practice and ICT integration.

Supporting the full learning co-design lifecycle

There exists a full range of technological tools to support teachers in LD. However, most of them lack flexibility, just focusing on specific parts of the LD process (e.g. conceptualisation or authoring) and they lack community features.

The ILDE (http://ilde.upf.edu/about; Hernández-Leo, Asensio-Pérez, et al., 2014)[1] overcomes LD tooling shortcomings by providing a set of integrated tools for the creation of learning design solutions (LdS). In ILDE, teachers can work individually or collaboratively with other teachers thanks to a set of provided community features (Hernández-Leo, Moreno, et al., 2014). The ILDE is built on top of the LdShake social platform (Hernández-Leo et al., 2011) and provides different tools for teachers along the complete LD lifecycle (conceptualisation, authoring and implementation), which is described by Pozzi et al., (2016, p. 174) as follows: first, the conceptualisation phase refers to the ideation of the learning situations including objectives, structure of contents and possible activities to be proposed (macro-design); second, the authoring phase includes the systematisation and contextualisation of the macro-design by detailing the activity flow and defining each activity (instructions, tools, learning resources etc.); and, third, the implementation phase deals with the automatic setting up of the technological platform for enacting the design, typically involving a learning management system (LMS).

Although the ILDE has previously been used in TPD (Hernández-Leo et al., 2011; Hernández-Leo, Moreno, et al., 2014), the existing studies have been limited to a specific part of the learning (co-) design lifecycle (the conceptualisation) in mostly face-to-face contexts. However, in the current TPD study, we explore the possibility to support the complete learning (co-)design lifecycle fully online, with a special focus on ILDE's co-design support.

Methodology of the study

The study was conducted in an online course within the Spanish Annual Programme of University Teacher Training. The course, entitled 'Design of Didactic Activities through the Use of the ILDE', was organised by the University of the Balearic Islands (UIB). The estimated overall effort of the participants, including individual and/or collaborative online activities, was 15 hours (three weeks). The learning environment managing resources and announcements of the course were made on the institutional Moodle-based LMS of the UIB. However, the main tasks of the course were conducted through the ILDE and its integrated tools (Figure 1). The course coordinator acted as a facilitator, solving the teachers' doubts and problems, providing feedback through the forums in Moodle and posting comments on the ILDE.

The findings from the literature on the topic of collaborative design in TPD were considered in the instructional model of the course. The participating teachers had to work in groups according to their teaching context (authentic and meaningful context), to change their designs according to the discussion on learning aspects and recommendations (cyclical nature of learning), subsequently modifying and sharing them (agency and sense of ownership) (Voogt et al., 2015). Although the groups were formed considering the disciplines of knowledge, each participant within the group had a specific domain of expertise, thus enriching and balancing the co-design process with cross-domain expertise (Kali et al., 2011).

Of the 33 initially enrolled teachers, 25 finished the course successfully. Twenty-two teachers formed nine teams according to their teaching field (see Table 1). The remaining three teachers worked individually owing to inactivity/dropouts in their groups and therefore were
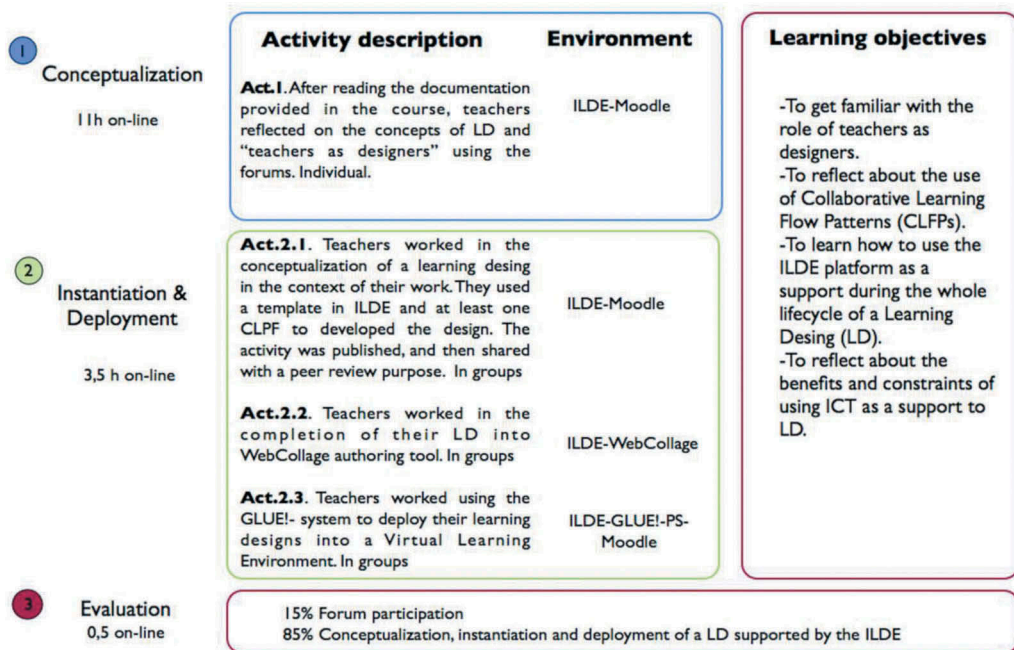
Figure 1. Description of the TPD course explored in the study. WebCollage and Glue!-PS are authoring and implementation tools, respectively, integrated within the ILDE.

Table 1. Configuration of the groups in the course.

Group ID	Teaching field	Number of participants
G1	Modern philology	3
G2	Management and business	2
G3	Economics	3
G4	Engineering	3
G5	Didactics of language and literature	2
G7	Didactics of experimental sciences	2
G8	Social and educational sciences	3
G10	Classical philology	2
G12	Pharmacology	2
	Total	22

not included in the study. Except for G12 and some of the members of G8, all group members were from different universities.

Of the teachers, 33.3% have more than 10 years of teaching experience, 23.3% have between 5 and 10 years of experience, and 43.3% have less than five years.

Fifty per cent declared that they always use ICT in their current teaching practice, 10% use it many times and 40% occasionally and/or never. Furthermore, 73.3% of teachers know pedagogical techniques such as work in groups and collaborative learning (30%). However, 66.7% did not have previous experience of working in groups using online tools. Forty per cent stated that they did not have previous experience or only had occasional experience of working in teams with teachers. On the contrary, 30% and 13.3% of the teachers declared that they work in teams very often and always, respectively. Surprisingly, when asked if they usually worked in a collaborative way with other teachers from their own discipline, 90% said no. However, teachers remarked that design activities in collaboration with teachers from other universities have many (73.3%) or some (23.3%) advantages.

The study is interpretive in nature since it tries to understand the particularity and richness of the phenomena under study, in this case the ILDE support for online co-design in higher education. This particular situation is approached in conditions as authentic as possible, gathering mostly qualitative evidence, and not trying to obtain statistically significant results or generalisations (Guba, 1981).

The research design of the study follows an exploratory sequential mixed strategy. According to that strategy, data were first analysed with a quantitative approach and, after that analysis, some groups were selected as embedded units of analysis in single cases (Yin, 2009). Thus, it was possible to analyse in more detail the results and explain them further using a qualitative approach.

The research question explored in this study was: 'How to support teachers in interuniversity teams to collaborate fully online along the LD process of a discipline-based situation that integrates ICT?'

The main research question is contextualised within the study presented by defining the following issue that will guide the interpretation of the data: 'How does the ILDE online co-design support help educators reach consensus and follow a full-lifecycle design process?'

The analysis of data gathered during the study was guided by a 'data condensation' process (Miles, Huberman, & Saldaña, 2013) (see Figure 2). The main issue of the study ('How does the ILDE online co-design support help educators reach consensus and follow a full-lifecycle design process?') is illuminated through two more specific topics:

- **T1: Does the ILDE online co-design support help educators reach consensus about their design decisions?** explores the way (and eventual difficulties) design teams are able (or not) to reach consensus about their designs.
- **T2: Does the ILDE online support help educators complete a full-lifecycle co-design with ICT?** explores whether the design teams were able to successfully complete their full-lifecycle co-design process using the ILDE, identifying emerging difficulties.

(RQ): How to support teachers in interuniversity teams to collaborate fully online along the learning design process of a discipline-based situation that integrates ICTs?

(Issue I1): How does the ILDE online co-design support help educators reach consensus and follow a full-lifecycle design process?

(Topic T1): Does the ILDE online co-design support help educators reach consensus about their design decisions?

　　IQ1.1. How do design teams reach consensus about their designs?

　　IQ1.2 What are the main difficulties for achieving consensus?

(Topic T2): Does the ILDE online support help educators complete a full-lifecycle co-design with ICT?

　　IQ2.1. Are the design teams able to complete their full-lifecycle co-design processes using the ILDE?

　　IQ2.2. What are the main difficulties for completing the co-design processes?

IQ1.1. Reaching consensus

IQ1.2. Difficulties for consensus

Topic T1 Consensus

IQ2.1. Able to complete designs

Topic T2 Complete LD process

Research Question (RQ)

Issue (I1)
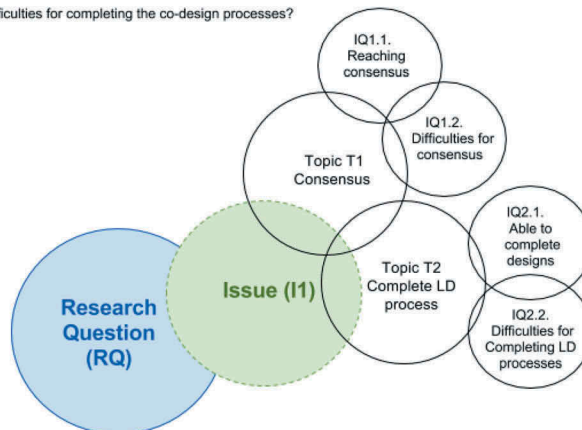
IQ2.2. Difficulties for Completing LD processes

Figure 2. Data condensation diagram, inspired from Miles et al. (2013), showing the Research Question (RQ), Issue (I), topics (T) and informative questions (IQ).

Moodle forums, comments on the designs and open questions in the final questionnaire were treated qualitatively. On the other hand, activity logs, designs versions and Likert-scale questions in the final survey were processed quantitatively.

Table 2 summarises the data sources used in the study.

Figure 3 depicts the flow of data gathering and analysis techniques employed throughout the study. The labels are defined in Table 2. Data were analysed using the elements of the data condensation diagram of Figure 2 as the initial set of codes. Coding was carried out by three researchers, although the codes themselves were discussed and agreed by the whole research team, as suggested by Saldaña (2015). The closed items of the questionnaires and the activity logs from the ILDE were treated quantitatively, using descriptive statistics, so as to confirm (or not) the findings from the qualitative analysis. In order to contribute to the quality and credibility of the study, several steps were taken, including (Guba, 1981): triangulation of techniques and data sources; peer debriefing between the three researchers that analysed the data and the rest of the members of the research team (including the discussion and agreement of the data condensation schema); and collection of thick descriptions of the context of the study.

Table 2. Data sources and their definitions.

| Data source type	Label	Definition
Team Forums	[Posts]	Messages posted (asynchronously) by members of the groups in order to share opinions and/or give feedback to others (Forums provided by Moodle).
Activity Logs	[Logs]	ILDE logs indicating who edited the designs (and when).
Questionnaires	[Quest-Pre]	Open-ended and closed items for collecting data about the experience, the background and expectations of the participants before the course started.
Questionnaires	[Quest-Post]	Open-ended and closed items to collect the opinion of the participants about co-design tasks and ILDE support, after the course finished.
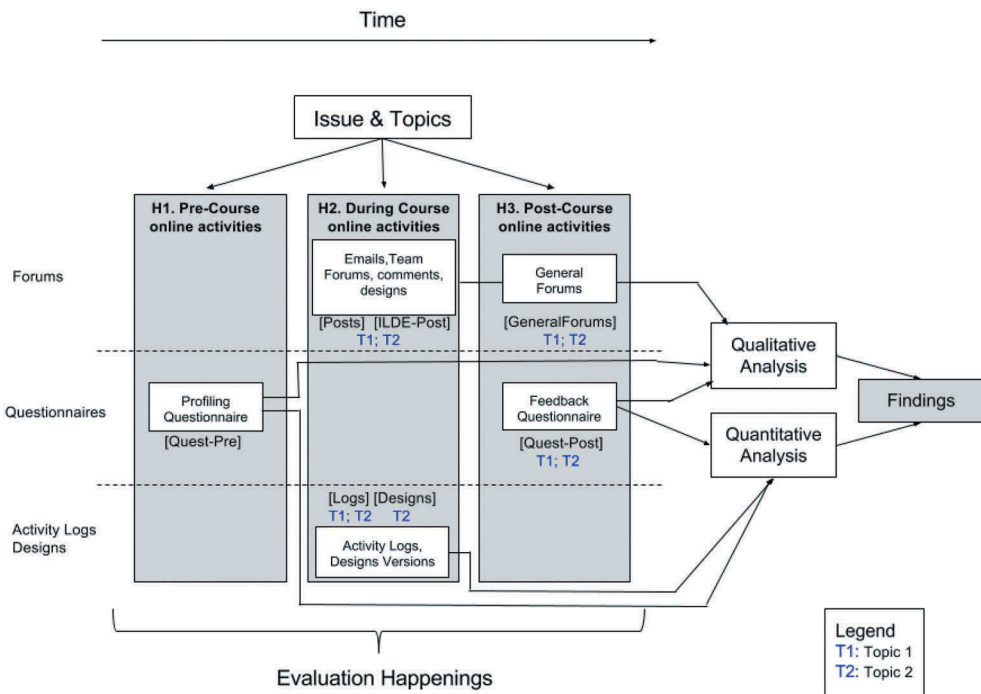
Figure 3. Data-gathering moments and analysis techniques during the study. See Table 2 for an explanation of the labels.

Results

Topic T1: Does the ILDE online co-design support help educators reach consensus about their design decisions?

In relation to how design teams reached consensus about their designs, as expected we found different patterns of interaction among team members. Selected excerpts of evidence for this section are in Appendix 1. According to the evidence gathered, the identified ways of collaboration were much more effective when based on the following aspects:

- Making explicit the changes that had been incorporated in the design and informing other members about it. After that, asking for feedback from group members (see, e.g., [Posts]$^{1-A}$, [Posts]$^{4-A}$).
- Distributing tasks and responsibilities among the group members (see, e.g., [Posts]$^{2-A}$, [Posts]$^{10-A}$).
- Providing ideas about learning resources which could be included in the design (see, e.g., [Posts]$^{5-A}$).
- Asking for and sharing clarifications about how to develop a particular procedure (see, e.g., [Posts]$^{2-B}$, [Posts]$^{7-A}$).
- Sharing opinions about the feedback provided by the course coordinator (see, e.g., [Posts]$^{2-C}$, [ILDE-Post]^9).
- Giving solutions for coping with the required changes (see, e.g., [Posts]$^{7-B}$).

Interestingly, most of the interactions among group members happened via Moodle Forums (41 forum threads for a total of 230 messages approximately). However, at some point, several groups realised that the use of the commenting feature of ILDE was more suitable, since it allowed comments to be associated to each of the design artefacts the groups were creating (see, e.g., [Posts]$^{3-A}$, [Posts]$^{4-B}$). The participating teachers posted a total of 138 comments in the ILDE. Figure 4 shows how those comments were distributed among the 23 design artefacts that were edited by more than one teacher.

The encouraging above-mentioned co-design interactions are reinforced by the opinions of several participants that reflect their positive attitude towards collaboration 'because when you work in a collaborative team, you can achieve better designs' ([Quest-Post]^2), although they also point out its challenging nature (see, e.g., [Quest-Post]$^{7-A}$). Similarly, the organisation of the course was also appraised by several groups, emphasising the guidance provided by the facilitator (see, e.g., [GeneralForum]$^{2-A}$, [GeneralForum]$^{10-A}$).

However, the collaboration was not fruitful among group members in all cases. For instance, in several cases the interactions within the groups had to do with communicating availability to contribute to the design rather than with making actual contributions, especially during the conceptualisation phase (see, e.g., [Posts]$^{1-B}$, [Posts]$^{5-B}$). It is true that sometimes they used the course forums to share their background and previous ideas about their teaching and learning experiences (see, e.g., [Posts]$^{8-A}$). However, the actual decisions (and the associated rationale) that the group members made regarding their co-designs were not in many cases explicitly shared through the forums (see, e.g., [Posts]$^{3-B}$, [Posts]$^{7-C}$). Thus, it was not uncommon that at some point in the interactions among the group members, one of them took the role of 'editor' and made changes to the co-designs, without waiting for explicit decisions to be made (see, e.g., the interactions among group members in [Posts]$^{8-B}$).

In addition to the collaboration problems, the participating teachers identified additional difficulties. For instance, seven (out of nine) design groups pointed out difficulties for finding time to devote to the course, as well as problems for synchronising those periods of availability among the group members, problems that might have impacted collaboration (see, e.g., [Posts]$^{1-D}$, [GeneralForum]$^{2-B}$, [Quest-Post]$^{3-A}$, [Posts]$^{5-B}$, [Quest-Post]$^{7-B}$, [Posts]$^{8-C}$). The participants also suggested improvements for the course regarding the collaboration and decision-making processes
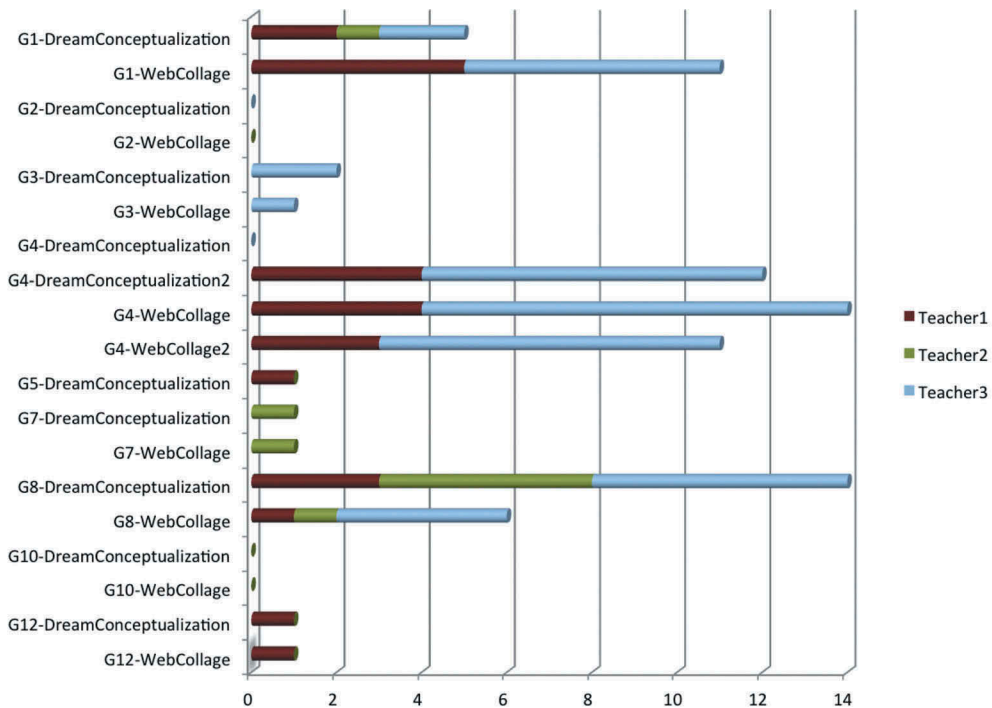
Figure 4. Distribution of ILDE comments among the 19 design artefacts that were edited by more than one teacher. The designs are identified by the group that created it, as well as by the tool used for its creation.

such as distributing tasks among the group members, assigning predefined roles, providing more time to deliver the tasks etc. (see, e.g., [Quest-Post][7-B], [Quest-Post][8]).

Interestingly, there were significant differences in the answers from the participating teachers when asked about their perception about the effectiveness of their group work (see [Quest-Post][ALL]). Indeed, groups 4 and 7, the ones giving the lowest ratings to their collaboration effectiveness, also explicitly stated collaboration as one of the aspects to improve in the course (see, e.g., [Quest-Post] [4-A], [Quest-Post][7-A]). These inter-group communication problems can also be appreciated when looking at how the LD artefacts were edited in the ILDE by the individual group members (see Figure 5). For instance, in the case of group 4 (see [Logs][4-A] and [Logs][4-B]), one of the group members did not actively edit one of the generated designs, there were several long time gaps between some of the editions, and most of the editing effort was carried out right before the delivery date of the corresponding design task. On the contrary, in the case of group 1, which valued very positively the collaboration within the group, the editing actions were much more balanced, and the reaction times after editing by other group members were also much shorter (see [Logs][1-A]).

Topic T2: Does the ILDE online support help educators complete a full-lifecycle co-design with ICT?

Regarding the role of the ILDE in supporting the participants in their ICT-enhanced co-designs, the overall reaction seems rather positive: 'it is an awesome tool that will be increasingly accepted in teaching practice. I do not know if in my University we have the possibility to connect it from Moodle. This way, I would not mind to make a request, asking my University to use it' [GeneralForum][4]; 'It has been a good experience in which I could learn a lot about the ILDE platform' [GeneralForum][9]; 'I have learnt new concepts as well as how to manage new ICT tools that I think could be very useful in the
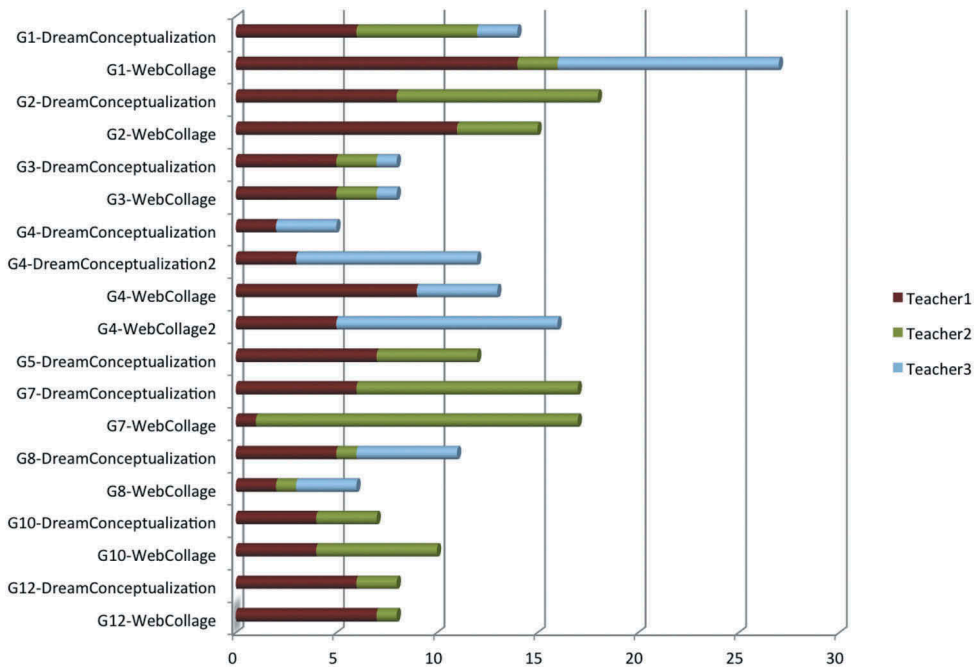
Figure 5. Distribution of ILDE edits among the 19 design artefacts that were edited by more than one teacher. The designs are identified by the group that created it and the tool used for its creation.

future' [GeneralForum][7]. Selected excerpts of evidence used in this section are in Appendix 2. Although several participants acknowledge that the ILDE is complex and not so easy to use at the beginning (see, e.g., [GeneralForum][1-A], [GeneralForum][2-A], [Quest-Post][8-A]), they also value positively its support to collaborate, reach consensus and share ideas about their learning designs (see, e.g., [GeneralForum][1-B], [GeneralForum][2-B]). In fact, some groups have expressed their interest in using the ILDE platform for future teaching practice (see, e.g., [GeneralForum][9-A], [GeneralForum][12-A]), even incorporating more complex learning designs (see, e.g., [GeneralForum][3-A]).

Curiously, to the question 'Which activity did you like the most?' [Quest-Post], 7 out of 18 participants answered 'the deployment of the activities in Moodle [part of the implementations phase of the ILDE]', emphasising the 'possibility to see all the cycle completed as well as to better understand the whole process' [Quest-Post][3] and the fact that 'I've seen our work in Moodle' [Quest-Post][7]. The deployment of the learning designs, i.e. the automatic setting up of the Moodle course according to the decisions made during the design process, is not a collaborative task. Thus, although some team members helped each other during the deployment of the designs (see, e.g., [Posts][2-A]), usually the actual deployment was carried out individually. As a consequence, some participants felt disappointed since they did not have the opportunity to contribute to that specific task (see, e.g., [GeneralForum][5-A], [Posts][5-A]).

However, during the course the participating teachers pointed out a variety of emerging difficulties of a different nature in relation to the ILDE. Eight (out of nine) design groups explicitly complained about the lack of documentation and/or examples for better understanding the tasks they had to carry out (see, e.g., [Quest-Post][3-A], [Quest-Post][4-A], [Quest-Post][5-A], [Quest-Post][10-A]). Among the most frequently pointed-out challenging issues, the participants mentioned understanding the terminology (see, e.g., [Quest-Post][8-B], [GeneralForum][11]) as well as the understanding of the exact role of the WebCollage authoring tool within the LD lifecycle (see, e.g., [Posts][1-A],

[Posts]3-A). In several cases, the ILDE is perceived as a complex platform to use, a complexity derived from the integration of different LD tools (see, e.g., [Posts]4-A, [Quest-Post]8-C).

In spite of these difficulties, six out of the nine participating groups were able to complete the whole LD cycle, including the implementation of their designs into a Moodle course. Groups 8, 10 and 12 were not able to complete the implementation phase, which is consistent with their level of activity during the course (see number of editions in Figure 5). On the contrary, groups 1 and 2, which showed a high level of activity in terms of number of editions of their designs (see again Figure 5), carried out a complete implementation of their designs [Designs]. The remaining groups (3, 4, 5, 6) were able to implement correctly only parts of their designs, in some cases with the help of the facilitator, who was satisfied with those partial implementations as a way of illustrating the complete design process [Designs].

During the unfolding of the course some sporadic technical glitches emerged, mostly related to Internet access problems and compatibility issues among the ILDE and Internet browsers (see, e.g., [Posts]1-B, [Posts]7-A).

Discussion, conclusions, future work

The analysis of the evidence gathered in this study sheds some light on the research question: How to support teachers in interuniversity teams to collaborate fully online along the LD process of a discipline-based situation that integrates ICT?

Mercier, Goldman, and Booker (2009) highlighted the benefits of designing interdisciplinary work teams, especially when the design problems are complex and require different types of knowledge and a high level of domain expertise. Some of the potential challenges are well documented in the literature: the years of teaching experience; the ICT beliefs; and the teachers' previous knowledge of the TPD approach, among others. Kali et al. (2011) identified as the main risk the situation when participants try to stick to their own approach to their respective disciplines. This can yield artefacts that lack integration between different knowledge domains, or artefacts that might be correctly developed from a technical point of view, but contain poor pedagogical ideas. Thus, there is a challenge in providing training experiences where the competencies among team members are balanced, in order to prevent these 'disciplinary cultural gaps'.

Collaboration between groups showed the situatedness of this process, by focusing on the learning design in authentic and meaningful contexts for the teachers. By interacting among them, they exchanged knowledge, perspectives and expertise (Voogt et al., 2015). The interpretation of the findings suggests that the instructional models of this type of online TPD might avoid potential barriers to effective co-design by: distributing roles and tasks among group members; facilitating explicit communication channels not only for design purposes but also for group coordination (e.g. explicitly asking for feedback before a certain deadline, availability for contributing); and, providing feedback and assistance by the course facilitators, which might contribute to better levels of motivation and co-design interaction.

Additionally, in spite of 90% of the teachers declaring that they did not have previous experience of working in collaborative teams with other teachers, the findings suggest that the ILDE provides an adequate support for co-designing online, its full-lifecycle nature being one of the most appreciated features. Similar to what Gros et al. (2016) mentioned, by checking the connection between the conceptualisation of a learning design and its deployment in Moodle, the rationalisation of the designs is facilitated. ILDE's community features (design versioning and commenting, co-edition) are also shown as useful elements for the co-design in our study (Hernández-Leo, Moreno, et al., 2014). All these encouraging findings underline the potential benefits of tools like the ILDE for supporting interuniversity collaboration. However, the use of ILDE-like platforms for TPD requires the instructional model to anticipate the learning curve of the co-design platform, especially when it implies, as in the case of the ILDE, the use of different design tools along the design lifecycle. The participants in the study provide some suggestions in this

regard: providing tutorials and/or examples for better understanding the ILDE-supported tasks to carry out, as well as the phases of the co-design lifecycle; and allocating longer time slots for fine-grained design tasks such as those related to the authoring phase.

According to the usual criteria to assure the quality and rigour in interpretive research (Ravitch & Riggan, 2016), we followed several strategies to increase the credibility, transferability, dependability and confirmability of our research. We applied a triangulation of methods, techniques and sources, thus enabling a thick description of the phenomenon under scrutiny, reported in detail to the whole evaluation team; peer review within the evaluation team to avoid bias; and triangulation of data sources and researchers to crosscheck data and interpretations. It is worth noting that the paradigm followed in this study aims at a deep understanding of the particularity and the richness of the concrete phenomena under study, instead of pursuing statistically significant results or generalisations. Likewise, these conclusions provide a roadmap for future improvements, applicable not only to TPD models based on online co-design, but also to full-lifecycle LD platforms, such as the ILDE, which made possible the challenging TPD scenario showcased. Other future research avenues include: exploring the online co-design TPD approach in educational contexts different from higher education; exploring group dynamics for better coping with the learning curve of the online co-design platform (e.g. each group member becomes 'expert' in specific design tools); and exploring the effectiveness of this approach to TPD when embedded in formal institutional programmes for teacher training.

Note

1. A short manual explaining the main functional features of the ILDE can be found at https://ilde.upf.edu/v/f4o.

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No potential conflict of interest was reported by the authors.

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Notes on contributors

Victoria I. Marín is currently a post-doctoral researcher in the Faculty of Education and Social Sciences at the University of Oldenburg (Germany). When the study was conducted, she was working as an associate lecturer of the Department of Applied Pedagogy and Educational Psychology (2013–16) and as a researcher of the Educational Technology Group (2010–16) at the University of the Balearic Islands (UIB, Spain). She received her PhD in educational technology at the UIB (2014) and is Research Collaborator of the Group of Childhood Technology, Education and Diversity, which includes the Educational Technology Group, of the UIB. Her research interests include personal learning environments, e-learning, social media in higher education, teacher training, e-portfolios and learning design.

Juan I. Asensio-Pérez received his PhD in telecommunications engineering from the University of Valladolid, Spain, in 2000. He is currently associate professor of telematics engineering at the same university. His research interests, within the field of technology-enhanced learning, include: learning design and its application to teacher training, computer-supported collaborative learning (CSCL) orchestration, the application of augmented reality technologies for the support of CSCL situations across multiple virtual and physical spaces, and the use of gamification and collaborative learning in Massive Open Online Courses.

Sara Villagrá-Sobrino received her PhD in pedagogy from the University of Valladolid, Spain, in 2012. She has been an assistant professor at the University of Valladolid since 2013. She is a member of the interdisciplinary group GSIC-EMIC. Her current research efforts are devoted to the study of the educational implications of technology-enhanced

learning scenarios with special emphasis on fostering teachers' skills during the design and the enactment of flexible CSCL activities in primary education with special attention to new ways of evaluating these particular settings.

Sara García-Sastre is an assistant professor in the Department of Pedagogy at the Faculty of Education and Social Work at the University of Valladolid, Spain. She is a member of the GSIC-EMIC research group. She has a PhD in pedagogy from the University of Valladolid developed in the field of CSCL in higher education, especially in the development of pre-service teachers' key competencies in the use of ICT and teacher training, both included in her research interests relating to technology-enhanced learning. Moreover, she currently takes an interest in the use of collaborative learning and gamification in Massive Open Online Courses.

Davinia Hernández-Leo is an associate professor and Serra Húnter Fellow at the Information and Communications Technologies Department of Universitat Pompeu i Fabra (Spain), coordinator of the Educational Technologies research of the Interactive Technologies Group, Vice-Dean of the Engineering School and Director of its Unit for Teaching Quality and Innovation. She received her Masters and PhD (2007) in telecommunications engineering at the University of Valladolid. Her research lies at the intersection of network and computer applications, human–computer interaction and learning sciences, and is focused on learning design, computer-supported collaborative learning, devices and architectures for learning environments.
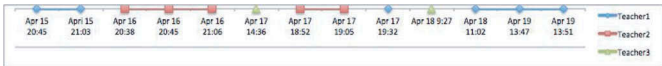
ORCID

Victoria I. Marín (iD) http://orcid.org/0000-0002-4673-6190
Juan I. Asensio-Pérez (iD) http://orcid.org/0000-0002-1114-2819
Sara Villagrá-Sobrino (iD) http://orcid.org/0000-0003-2516-0492
Davinia Hernández-Leo (iD) http://orcid.org/0000-0003-0548-7455
Sara García-Sastre (iD) http://orcid.org/0000-0002-1196-2892

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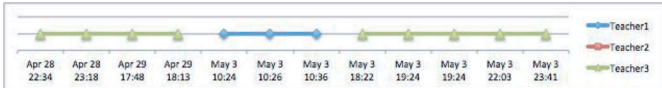
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Appendix 1. Selected excerpts of evidence for Topic 1 (Reaching Consensus)

Data source	Group	Excerpt
[Posts]	1	[A][PA Teacher]: 'In order to foster the use of ICTs, we can ask the students to create a GoogleDocs document so that they can write down the improvement actions in pairs; thus, everyone will benefit from the comments made by all and, additionally, repetitions will be avoided. What do you think?' [B][JM Teacher]: 'I introduced modifications in WebCollage in the teacher section. What do you think?' [C][JM Teacher]: 'Great! I'll take a look at it tomorrow. I'll be also in a Conference on Thursday and Friday and inform the others when they've made changes.' [D][RS Teacher] 'I started the activity 2.3, although I do not have much time to devote to it, I will take a look next week when I come back from the congress.'
[Logs]	1	[A]Editing moments (and editing teachers) of the first conceptualisation design of Group 1.

Apr 15 20:45 · Apr 15 21:03 · Apr 16 20:38 · Apr 16 20:45 · Apr 16 21:06 · Apr 17 14:36 · Apr 17 18:52 · Apr 17 19:05 · Apr 17 19:32 · Apr 18 9:27 · Apr 18 11:02 · Apr 19 13:47 · Apr 19 13:51 — Teacher1 / Teacher2 / Teacher3

Data source	Group	Excerpt
[Posts]	2	[A][CA Teacher]: 'I have seen that the activity can be divided in 4 sections. We can divide the work according to these sections. I can develop the context and the objectives and you can edit the design and the evaluation. Finally we can take a look at the whole document and introduce final changes before delivering the design.' [B][CA Teacher]: 'I attach a Word document that contains the last two sections of the design. I tried to include it in ILDE but it was impossible. I cannot edit.' [GB Teacher]: 'You cannot probably edit the document because I was editing at the same time.' [CA Teacher]: 'Perfect! I can edit.' [C][CA Teacher]: 'In resources, the coordinator pointed out that Moodle and Google can be deleted, because we will plan to use them in activity 2.3. I prefer not applying the modifications because this way we have a better organisation of the resources that we want to use. Tell me what you think.' [D][PA Teacher] 'I like two collaborative learning patterns: pyramid and peer-review. I guess we should consider which content we should use in the activity… something general related to English language, or rather didactics?' [RS Teacher] 'I prefer peer-review. This afternoon I'll take the model and make a proposal so that you can give your opinion.[…] For me both English and Didactics are Ok. Whatever you decide.' [JM Teacher] 'If you agree, I'll vote for didactics, since I belong to French (area).' (and without further interactions, [JM Teacher] realises that someone else made changes to the co-design…) [JM Teacher] 'I've checked that activity 2 is quite complete.'
[Quest-Post]	2	To the question: Describe shortly the reason for your agreement/disagreement with the following question: Did ILDE facilitate the co-design of a learning situation with other teachers? Answer: 'I understand the design as a discipline that requires experience. When you work in a collaborative team, you can achieve better designs.'
[GeneralForum]	2	[A]'I want to congratulate the coordinator for the huge work providing feedback and help due to the lack of time and the number of groups.' [B]'I'd suggest solving, however, the synchronisation problems, since in a remote co-design each member has its own schedule and sometimes it is difficult to follow the same working pace.'
[Posts]	3	[A][CF Teacher]: 'I begin to feel lost, due to the use of the tool (WebCollage) and because I do not know what we want to do in the next step. We made a design flow but I do not know what the objective of this activity is and what we can do with WebCollage. What do we have to do? A graphic with all the steps to be followed? A didactic unit? In Moodle we can make all these things. What do you think ASG Teacher?' [B][MAG Teacher]: 'Hi, I added comments in ILDE on the section information and comments. I prefer to introduce my comments this way instead of putting the comments directly in the document.' [C][ASG Teacher]: 'Tomorrow is the last day to deliver the task. I will be very busy tomorrow but I can devote time to complete the activity at midday and at the end of the day.' [ASG Teacher]: 'I am very busy but tonight or tomorrow morning I can devote time to activity 2.3.' [CF Teacher] 'No worries. Until Wednesday I have a crazy schedule, so we will see how can we organise it without problems.' [D][ASG Teacher]: 'I send activity 2.1. I have opened a new thread for issues about activity 2.2. I created a design in WebCollage and I edited the objectives. We want to focus on the design flow but I am not sure how it works. How can we share the work?' [CF Teacher]: 'Hi ASG Thank you for making the work more dynamic.'

(Continued)

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Data source	Group	Excerpt
[Quest-Post]	3	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'Too short a time to appropriate things. It should last longer.'
[Posts]	4	[A][T Teacher]: 'We can make a brainstorming. I put several pictures in Google Drawings in the resources section. I think that we should help students with questions to focus on specific aspects: e.g. how many bicycles? What will be the format? We can use GoogleDocs.' [B][TC Teacher]: 'Take a look at what I have found. It is a Master Degree Thesis about the design and selection of materials for a bicycle parking http://repositori.uji.es/xmlui/bitstream/handle/10234/107522/TFM_2013_tenaD.pdf' [C][TC Teacher]: 'I realised that we have an option in ILDE (view section in the toolbar) to put comments in the same design. I think that this is interesting, because it is easier to write there than on the forum. I put some comments about our design.' [D][T Teacher] 'I have a trip tomorrow, I do not have Internet until Sunday. Please can you go ahead with the LDs? When I come back I will take a look at the advances made in activity 2.2 and I will make contributions.' [E]'I must confess that I feel very frustrated. I don't like leaving tasks unfinished… but we're a team and, well, what we do is a joint decision. I understand that you have other responsibilities and lack of time and you can devote more time: nobody told us that collaboration and coordination would be "compulsory".'
[Quest-Post]	4	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'I think it is a pity that communication problems and/or differences in personal goals within a group might imply the "failure" of the activity, without knowing (or being able) to avoid it.'
[Logs]	4	[A]Editing moments (and editing teachers) of the first conceptualisation design of Group 4. [B]Editing moments (and editing teachers) of an improved version of the conceptualisation design of Group 4.
[Posts]	5	[A][G Teacher]: 'You can take a look at scoop.it as an example as well as a manual about how to use it http://www.scoop.it/t/languagelearning8 http://es.slideshare.net/flosflorum2/tutorialscoopitenespaolpasoapaso)' [B]'This afternoon I'll take a look at the second activity; tomorrow I'm leaving for a conference and I don't know whether I'll be able to participate before next Monday, so if I don't post in the forum it is not because I've given up.'
[Posts]	7	[A][FMTeacher]: 'With respect to the pdfs, I do not know where they can be uploaded. Do you know it?' [MGTeacher]: 'As far as I understood I think that we have to put a link with the resources. We can upload the documents to dropbox and get the shared link.' [B][BM Teacher]: 'The coordinator is asking us to put more effort in the following aspects: find real problems, provide a guide to the students to help them in problem solving, generate a pdf with instructions, create a questionnaire. I have been working in the two first. Can you take a look?' [C][FMTeacher]: 'Hi, I have been working in the Task 2.2 during this week. Take a look and feel free to introduce changes.' [MGTeacher]: 'The proposal is great! Awesome! I added minor changes-'
[Quest-Post]	7	[A]To the question: 'Explain shortly your opinion about the online format of the course about ILDE.' Answer: 'It has been very positive, although working in groups online is very difficult. There is part of the group that works harder than the other, and communication is not good.' [B]To the question: 'please, specify how the course might be improved'. Answer: 'distributing the tasks among members, identifying and assigning roles in each group, granting longer time for completing the tasks of the course'.

(Continued).

Data source	Group	Excerpt
[Posts]	8	[A][ALTeacher]: 'I always try to introduce contents in my designs related to gender issues, inclusion, equal opportunities, as well as educational inequality who specially affects Romani people.' [B][G Teacher]: 'My background is in psychology, in childhood education.' [C][ALTeacher] (editing without waiting for others' opinions): 'I have logged into the ILDE and I cannot see any shared activity, so I assume that no one has been able to start it yet. I created one design with the name of Group 8. I have created a basic structure (context, motivation, objectives, design and evaluation) following the example provided in the resources section. Please feel free to make changes in the design proposal.' [ALTeacher] (starting a new activity without waiting for others' opinions): 'If all of you agree with the proposal, I can upload the activity 2.1. I have begun with task 2.2, as I wrote in the LDs comments, you can feel free to modify whatever you want.' [LRTeacher] (realising that [ALTeacher] has already progressed alone…): 'I am happy that finally we can fix our profiles and make an activity proposal. Go ahead with the publication of activity 2.1. I saw your advances in activity 2.2. Excellent work! I am trying to get used to the tool.' [D]'It was a race against time, and I think that it was unnecessary. I am happy that finally you can see the tasks completed. Everybody has criticised the lack of time to process all the new information.'
[Quest-Post]	8	To the question: 'Explain shortly your opinion about the online format of the course about ILDE.' Answer: 'I am not used to a completely online course that has made the task difficult for me.'
[ILDE-Post]	8	[GL Teacher]: 'I have just seen that the course instructor said that we should include the resources that we will plan to use. Maybe each member of the group can put a link from our respective field of study.'
[ILDE-Post]	9	[MAA Teacher]: 'I made the changes suggested by the course coordinator.'
[GeneralForum]	10	[A]'The availability of the coordinator was very good and I appreciate it a lot.'
[Quest-Post]	ALL	To the question: 'Please, rate the following aspects of the course (1 = very low, 5 = very high) [Effectiveness of group organisation]: out of the 8 groups that answered: 5 (Groups 1, 10) 4 (Groups 2, 3) 3 (Groups 5, 8) 2 (Group 7) 1 (Group 4)

Appendix 2. Selected excerpts of evidence for Topic 2 (ILDE support)

Data source	Group	Excerpt
[Posts]	1	[A](When talking about problems in group configuration with WebCollage) 'No matter how much I search, I cannot see the problem. We might deliver it, no?. I think the problem was in WebCollage, but I cannot find it.' [B]'The page cannot be loaded. My internet access at home does not work properly.'
[Quest-Post]	1	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'Maybe some information about the workflow diagrams [in WebCollage], but everything has been unimprovable.' [B]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'An initial course about terminology, with doubts and answers.'
[GeneralForum]	1	[A][JMTeacher] 'The ILDE platform is not simple to use, but quite useful and well presented. I liked this course a lot, because I have had the opportunity to learn unknown concepts and use tools that helps us reach common objectives, proposals, ideas.' [B][PATeacher] 'My experience working in groups have been awesome. We have collaborated, we helped each other and each one of the members have contributed with their ideas. Group collaboration allows to learn from others and shows other ways of teaching and learning. I have learnt a lot from my colleagues.' [C]'I think it was very useful to learn how to use ILDE. I'm sure that I will use it the next academic year.'
[Posts]	2	[A][CATeacher]: 'The course coordinator asked us to delete the resources Moodle and Google, because we included them in activity 2.3. I would prefer to leave it like this, because we have a better organisation of what is supposed to be used. Anyway if you want we can delete it. If you agree, we can deploy the design.' [CATeacher]: 'It is awesome, it is rather complete!' [B]'In any case, if you still have problems, try with a different Internet browser. Mine is not working very well either.'

(Continued).

Data source	Group	Excerpt
[Quest-Post]	2	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'Since many of us are not experienced [in the topic of the course], it would be helpful to include some examples.'
[GeneralForum]	2	[A][GBTeacher] 'Without doubt it have been a good experience to known different possibilities to learning design. To be honest, the platform is not agile enough but once you have learned how to use it, is faster. Moreover, I supposed that many people is working to improve these learning design tools.' [B][GBTeacher] 'According the co-design I think that ICT are an opportunity to collaborate among teachers as designers around the world.'
[Posts]	3	[A]'…and with WebCollage I don't know either what can be done nor its goal, beyond creating a schema of the steps to take…' (Teacher 2): '…I was trying to understand WebCollage because I'm not able to understand its goal. I imagine we don't understand it because we're making a very basic design…' [B][ASG Teacher]: 'I have made changes to a section for the discussion in supergroups. I also added documents in Word and presentations. I have tried to see the implementation in Moodle but I have problems with the password. What a mess with the passwords! I am waiting for a new password to arrive via email. Meanwhile you can take a look and tell me what you think.' [MAG Teacher]: 'Hello, thanks [ASG Teacher]. I have seen the implementation in Moodle. The password and the user is '***.' I think that the task is now completed. I do not know if I would have been able to do it alone.'
[Quest-Post]	3	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'See examples of implementations in different contexts.'
[GeneralForum]	3	[A]'In our team, we have not developed a complex learning design. I would like to put into practice more complex learning designs to see the process step by step. Thus, I will do some research using the [ILDE] platform.'
[Posts]	4	[A][TeacherS]: 'I have been lost in the manage of the tool. I know what I want but when I used the platform I feel desperate.'
[Quest-Post]	4	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'Actually, there was no training at all. Only autonomous learning without good guiding tutorials.'
[Posts]	5	[GTeacher]: 'The way in which certain activities were designed implied that only one member of the group could be in charge of carrying it out. For this reason, some members have not been able to practise. I think this has been negative. I am sorry.'
[Quest-Post]	5	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'I think that it lacks more theory for framing the activities and understanding their rationale.'
[GeneralForum]	5	[A]'The management of the tools it has been a bit complex to me, but I understand that more practice is needed.' [B]'Regarding the collaboration in groups, there are some tasks that only a person can make at the same time. Thus, some members have not been able to practise certain steps. Maybe this can be improved in the future.'
[Posts]	7	[A]'Let me tell you that at the beginning I couldn't input resources and goals [in WebCollage] because the browser didn't work well. I was working with Chrome, then I switched to Firefox, and now I can enter them.'
[Quest-Post]	7	[A]To the question: 'Explain shortly your opinion about the online format of the course about the ILDE.' Answer: 'It is a bit complex to understand. I think it should be made easier, maybe with videos?. In a tutorial fashion, for instance.'
[Quest-Post]	8	[A]To the question: 'Describe shortly the reason for your agreement/disagreement with the following question: Did the ILDE facilitate the co-design of a learning situation with other teachers?.' Answer: 'It was a new tool and at the very beginning I did not have a clear idea.' [B]To the question 'Please, indicate what might be improved [in the course].' Answer: 'Generally speaking, I'd change the initial readings, since they used a terminology I'm not familiar with.' [C]To the question: 'Explain shortly your opinion about the online format of the course about the ILDE.' Answer: 'Maybe too many platforms. If they all could be integrated in a single one, everything would be simpler.'
[Quest-Post]	10	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'For the practical assignments I needed some more information or clearer information.'
[GeneralForum]	9	[A]'I have to recognise that it was a pleasure see what we can use this kind of tools in social sciences courses. We have to overcome limitations between pure sciences and social sciences and the use of ICT. I will use this kind of activities in the next course.'
[GeneralForum]	10	[ER Teacher] 'The course was interesting because I learn how to use a new tool. I have had some problems in understanding its management, and I am not sure if I finally understood it well.'
[Quest-Post]	11	[A]To the question: 'Please, indicate what might be improved [in the course].' Answer: 'Some more practice to reinforce the knowledge.'
[GeneralForum]	11	'It's true that the use of language (e.g., technical terms) and the way to work within the course are complex. I'm not sure I'm understanding well enough how ILDE works.'
[GeneralForum]	12	[A][TM Teacher] 'I think that ILDE is a good tool, and I will use it in the future. I think that it can be a complement to Moodle.' [B][CM Teacher] 'The course was easy to follow and the ILDE platform was a nice discovery that I'm sure I will use in the future.'