Lost in Translation from Abstract Learning Design to ICT Implementation: A Study Using Moodle for CSCL

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Abstract: In CSCL, going from teachers´ abstract learning design ideas to their deployment in VLEs through the life-cycle of CSCL scripts, typically implies a loss of information. It is relevant for TEL and learning design fields to assess to what extent this loss affects the pedagogical essence of the original idea. This paper presents a study wherein 37 teachers' collaborative learning designs were deployed in Moodle with the support of a particular set of ICT tools throughout the different phases of CSCL scripts life-cycle. According to the data from the study, teachers considered that the resulting deployment of learning designs in Moodle was still valid to be used in real practice (even though some information is actually lost). This promising result provides initial evidence that may impulse further research efforts aimed at the ICT support of learning design practices in the technological context dominated by mainstream VLEs.

Keywords: CSCL, Moodle, learning design, life-cycle, VLE, translation

1 Introduction

Effectiveness of collaborative learning depends on multiple factors, including the way interactions among learners are promoted, structured, and regulated [1]. Such learner scaffolding may be achieved through Computer Supported Collaborative Learning (CSCL) scripts, that can take the form of computationally interpretable specifications of a desired collaboration process [2]. CSCL scripting can be considered a specific form of learning design [3], focused on collaborative learning pedagogical principles and techniques.

Different approaches in the literature identify the phases that CSCL scripts go through during their "life-cycle", from initial inception to enactment. For instance, phases for specification, formalization, simulation and deployment are proposed in [2], while design, instantiation and enactment are mentioned in [4,5]. Additionally, operationalization is used instead of instantiation (i.e. design, operationalization and execution) in [6].

As we can see, the phases considered in such life-cycle can change depending on the methodologies and tools used, or on other factors. Moreover, the script life-cycle

does not need to be lineal, with perfectly differentiated phases [6]. Nevertheless, different approaches have in common that, from the CSCL script's conception in the mind of its author, up to its final form ready to be used in a concrete computer-supported scenario, the script has to traverse different human or computer agents, in which it is completed, particularized or modified. It is also noteworthy that, in many educational institutions around the world, the technological environment in which CSCL scripts are deployed, executed or enacted (depending on the approach followed) often is a Virtual Learning Environment (VLE) [7] such as *Moodle*[1], *Blackboard*[2], *Sakai*[3] or *LAMS*[4].

However, supporting the life-cycle of CSCL scripts using different software tools until its deployment in a widespread VLE may introduce changes in the original idea of the learning designer [8]. Typically, several software agents (e.g. design authoring tools, instantiation tools, VLEs, etc.) and human agents (teachers, instructional designers, etc.) will be involved in this script life-cycle, with different data models and different conceptions/understandings of the design, respectively. Thus, in the end, the result (e.g., a course in *Moodle*) may not reflect the original abstract ideas and the pedagogical intention of the designers (e.g. a teacher), due to the multiple translations performed during the whole process.

To the best of our knowledge, there is a dearth of examples in literature studying these transformations from abstract inception to deployment in a particular VLE. However, we do believe that this transformation is highly relevant for the learning design and technology enhanced learning (TEL) research fields. If the changes are too large, the pedagogical essence of the original design idea may be fatally modified, and the resulting course may no longer be valid to be enacted in the teacher's class (which somewhat decreases the usefulness of making learning design decisions explicit). Finding means of applying learning design tools and methods to existing, widespread ICT learning environments, is an issue that can "make or break" the applicability and impact of learning design on a wider scale.

The objective of this paper is to study the CSCL script life-cycle of a set of 37 CSCL learning designs devised by higher-education teachers from different disciplines, in the context of two professional development workshops. The paper tries to clarify at what points of the scripts life-cycle the information changes, what is the nature of those changes, how much information and what information is lost. Our ultimate goal is to ascertain how these changes affect the fidelity of the result in a VLE, to be enacted in a real situation by a teacher.

The structure of the paper is as follows. Section 2 presents the problem of the translations when going from a learning design idea to a VLE-based infrastructure, following the life-cycle of CSCL scripts. In Section 3, 37 designs from two workshops are analyzed, to evaluate to what extent the final result in a widespread VLE (such as *Moodle*) maintains the pedagogical essence of the original idea. Section 4

1 http://moodle.org (Last access 3/22/2012)
2 http://www.blackboard.com (Last access 3/22/2012)
3 http://sakaiproject.org (Last access 3/22/2012)
4 http://www.lamsfoundation.org (Last access 3/22/2012)

discusses the results, and finally, the main conclusions and future research lines are described in Section 5.

2 The Problem of Translations in the Life-Cycle of CSCL Scripts

Several ICT tools may support one or more phases of the life-cycle of CSCL scripts (e.g., a set of learning design tools can be found in *The Learning Design Grid*[5]). Some tools, as e.g. *Reload*[6], *Collage* [9] or *ReCourse*[7], focus on supporting the design phase and follow a particular specification of learning design language [10,11] like IMS LD [12], while others employ their own proprietary data model (*CompendiumLD*[8], *Pedagogical Pattern Collector*[9]). Other tools focus on the instantiation phase, as e.g. *InstanceCollage* [5] and *CopperCore*[10], or cover both design and instantiation, such as *WebCollage*[11]. Finally, *GLUE!-PS* [13] is a tool dealing with instantiation and deployment that allows deploying learning designs from multiple learning design language/authoring tool to multiple VLEs.

On the other hand, most widespread VLEs like *Moodle*, *Sakai* or *Blackboard* focus only on enactment/execution. LAMS, on the contrary, provides support to the complete life-cycle (including learning design), and it is an example of an easy-to-use integrated approach. However, such an all-in-one approach does not allow taking advantage of affordances provided by other design tools and thus, sharing and reusing design resources outside the *LAMS* VLE becomes difficult for practitioners. Finally, *LAMS* is not as widespread as *Moodle* or *Blackboard*[12], and therefore it may not be available (or practical) for many teachers, due to institutional VLE choices.

All in all, there is a diversity of computer agents (tools) potentially involved in the CSCL script life-cycle. Additionally, it is frequent to have more than one human agent (teachers, instructional designers, etc.) using the aforementioned tools in different moments of the process. It is thus important to know what occurs with the pedagogical essence of a script along this process, from being an idea in the mind of, e.g., a teacher, up to its crystallization as a set of resources ready to be used in a VLE.

In general terms, the information in the script can change each time it traverses machine or human agents: because of human or machine action, or due to a human to machine interaction. For instance, information can be lost when a third party, e.g. an instructional designer, interprets a teacher design. Also, data may be modified to be adapted to the specific data model used by a supporting tool. Information may be lost

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5 http://www.ld-grid.org/resources/tools (Last access 3/22/2012)
6 http://www.reload.ac.uk/ldesign.html (Last access 3/22/2012)
7 http://tencompetence-project.bolton.ac.uk/ldauthor/ (Last access 3/22/2012)
8 http://compendiumld.open.ac.uk (Last access 3/22/2012)
9 http://tinyurl.com/ppcollector3 (Last access 3/22/2012)
10 http://coppercore.sourceforge.net/ (Last access 3/22/2012)
11 http://pandora.tel.uva.es/wic2 (Last access 3/22/2012)
12 Three month Traffic Rank at alexa.com (03/30/2012): blackboard.com: 1,709; moodle.org: 4,285; lamsfoundation.org: 937,821

as well because of a lack of expertise of the user of any of the supporting tools, or due to missing information in the formalization or interpretation of the learning design.

Figure 1 shows an example of three generic ICT tools supporting the life-cycle of a CSCL script. Each time the CSCL script traverses a human or a machine agent (an ICT tool in the example), the information in the script can change.

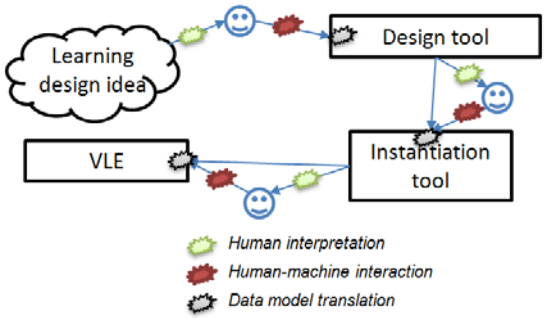

Fig. 1. Potential points of modification/loss in a typical CSCL script life-cycle

So far, research initiatives have not analyzed the information loss that might occur during the complete life-cycle, and therefore evidence should be provided on the fidelity of the final product (e.g. a course or activity ready to be used in a VLE), compared to the original learning design idea. If such a product has lost the pedagogical essence of the original idea, it may not result useful to be enacted by the teacher in a real situation. Thereby, it is necessary to study the degree of alignment of this "reified script" and the pedagogy underlying the original learning design idea. Evidence on the information loss may contribute to the design and development of appropriate supporting tools, and help researchers in understanding the complete life-cycle.

3 A Study: From Learning Designs in a Workshop to Moodle

3.1 Description of the Study

In order to study the loss of information when following the CSCL script life-cycle from abstract design to a widespread VLE, two workshops on professional development were conducted and analyzed at the University of Valladolid, the first one in June and September 2011, and the other in February 2012. The workshops focused on designing CSCL activities and participants were faculty members from multiple fields (e.g. Computer Science, Medicine, Biology, etc), with varying ICT abilities. Both workshops had a blended learning format, with two 4-hour face-to-face sessions and a number of tasks to be accomplished on-line between sessions. The first session was devoted to the creation of a technology-enhanced collaborative learning design by means of a Pyramid collaborative pattern [14]. After this initial session, each participant was asked to particularize such a learning design to one of his/her own courses, using a collaborative pattern. The designs produced by teachers were free-form,

natural language descriptions of the design ideas, often with accompanying graphical schemata. Even though participants were free to choose any collaborative pattern for their designs, the Pyramid was recommended because of its relative simplicity. Nevertheless, descriptions of other patterns such as Jigsaw, Think-Pair-Share or Brainstorming, were available as workshop handouts. In addition, other characteristics were recommended to be included in the designs: whether a task is face-to-face, blended or remote, estimated times for completion of activities, grouping structures, ICT tools used to support a task, objectives, etc. Interestingly, the second workshop introduced this in a more formal way: participants were provided with a template identifying a list of characteristics to be considered for their inclusion in the learning designs to be generated by teachers. Again, the usage of the template was not mandatory and was solely intended as a recommendation.

Afterwards, each of the learning design created by the workshop participants was used as input by a (human) third party to complete the remaining CSCL script life-cycle phases, to produce a course in *Moodle* according to the designs. Twelve of these designs were completed in the first workshop, and twenty five more in the second one. The third party role was played by an ICT-expert researcher, who used the *WebCollage* learning design tool to convert the teachers' designs into computationally interpretable scripts. Then, the scripts were deployed automatically in *Moodle* using *GLUE!-PS*.

Figure 2 shows the particular CSCL script life-cycle employed in this study, with an example of the life-cycle of one of the scripts, as well as the critical points (in green, red and black) where information of the script might have been lost. The context described so far serves to settle the research question driving the whole study:

[QG]: *Does the final result of the designs in Moodle maintain the pedagogical essence well enough to remain usable by their original authors (faculty)?*

In order to answer the research question, we employed a mixed evaluation approach [15], gathering both quantitative and qualitative data.

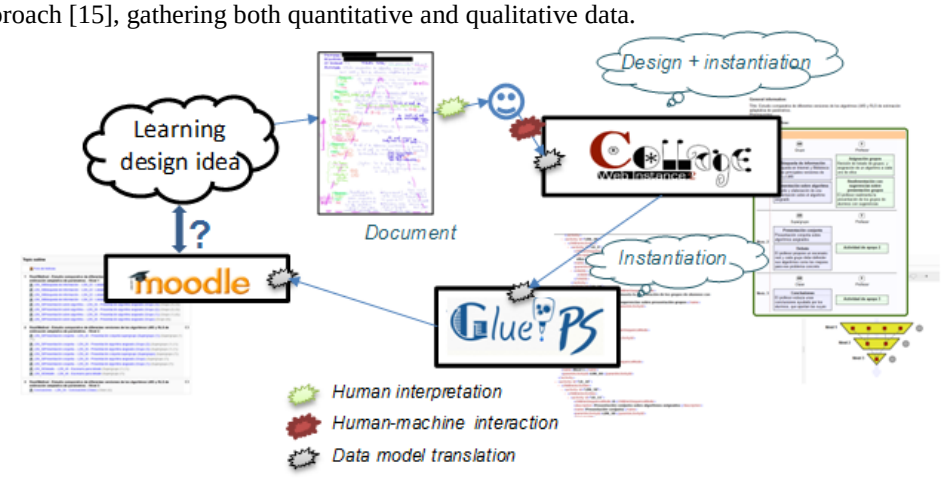

Fig. 2. CSCL script life-cycle and points of change in the use case

3.2 Context and Methodologies of the Study

As mentioned above, the study was carried out in the context of two workshops at the University of Valladolid, on the topic of design and deployment of advanced collaborative activities using ICT. To help with the planning and organization of the evaluation, we followed the *Evaluand*-oriented Responsive Evaluation Model (CSCL-EREM) [16], using a variety of quantitative and qualitative data gathering techniques. The model is deeply focused on the *Evaluands* (the subject under evaluation), and it is framed within the Responsive Evaluation approach [17]. According to this, the model is oriented to the activity, the uniqueness and the plurality of the *Evaluand* to be evaluated, promoting responsiveness to key issues and problems recognized by participants at the site. The model includes three core parts (*Perspective*, *Ground* and *Method*) that could be taken into account while doing an evaluation, a representation diagram to help evaluators in the planning stage, and a set of recommendations to write the report of the evaluation. The emphasis of the *Perspective* has to do with the point of view from which we are conducting the evaluation. *Ground* is the context in which the *Evaluand* takes place or is intended for. *Method* is the sequence of steps that lead the evaluation process [18].

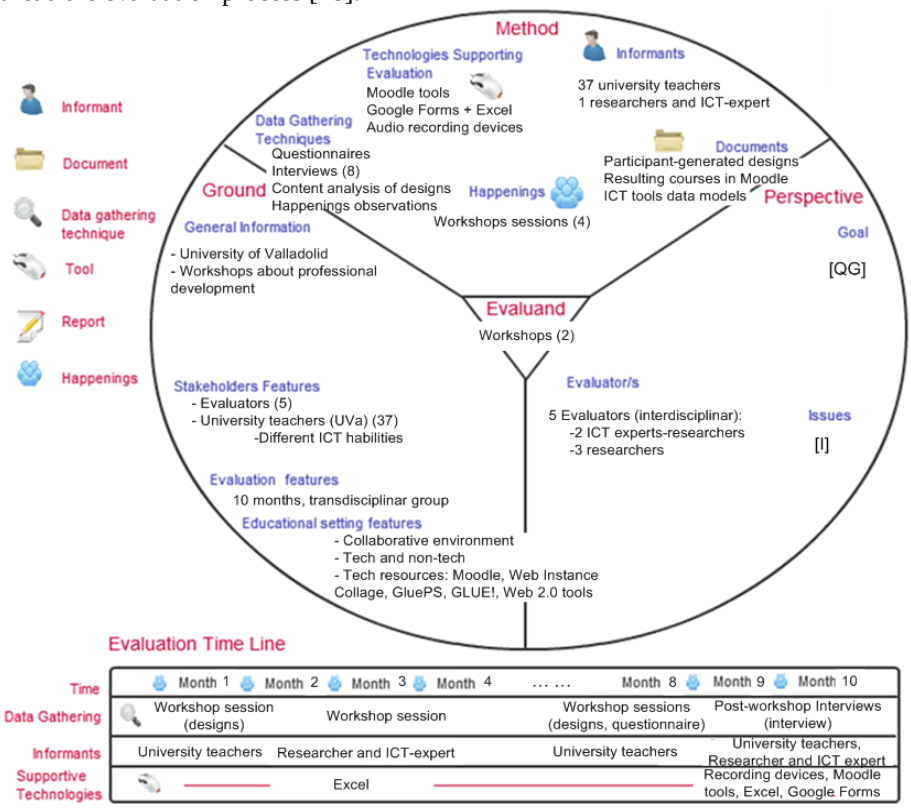

Fig. 3. Planning of the evaluation using the CSCL-EREM model. [QG] refers to the research question (section 3.1) whereas [I] refers to considered evaluation issue (section 3.2).

Figure 3 shows the planning diagram of the evaluation conducted, using the aforementioned CSCL-EREM model. The diagram shows that the *Evaluand* corresponds to the two workshops. The *Perspective* is that of a *research* work. The *Ground* is a context of the two workshops already mentioned, wherein the participants were 37 university teachers, and the organizers 5 interdisciplinary researchers (the evaluators). The workshops' environment was collaborative, and in a mixed form of technological and not technological, using both physical materials (e.g. pen/paper) and ICT tools.

The *Data Gathering Techniques* used in the evaluation process were: interviews (8); Web-based questionnaires (24); naturalistic observations of the 4 *Happenings* (workshops' face-to-face sessions); as well as a quantitative content analysis of the designs. Such a content analysis of the designs consisted of: structuring the designs in facets (or characteristics); studying the occurrence of each facet in the 37 designs; and, analyzing where those facets were lost in the CSCL script life-cycle. The content analysis performed in both workshops was confronted in an iterative way, finding that in the second one, more facets were considered. This way, the analysis of the design contents of the first workshop was enriched by incorporating the new facets arisen from the second one.

In the second workshop, additionally to the aforementioned content analysis, feedback from the teachers was gathered, in the form of a Web-based questionnaire and interviews. In total, we processed 24 answers to the questionnaire (out of 25 participants), and eight interviews with the aim of triangulating data by asking teachers to compare the resulting *Moodle* infrastructure with their original designs. Access to the corresponding deployed *Moodle* course was granted to all participants (with both student and teacher roles) so that they had the opportunity to assess the result of the translations.

A summary of the data gathering sources, and the labels used in the text to quote them is shown in Table 1.

Table 1. Data sources for evaluation and labels used in the text to quote them

Data source	Type of data	Labels
Web-based questionnaire	Quantitative ratings and qualitative explanations of the teachers	[Quest]
Designs content analysis	Quantitative data about facets, occurrence of facets, and facets lost in translations (quantitative data analysis)	[Content]
Interviews	Qualitative interview with teachers	[Interview]

As recommended by the evaluation model followed, the study involved 5 researchers coming from different perspectives in the ICT and education fields, who jointly defined the evaluation *Issue* (Tension) as the conceptual organizer of the whole evaluation process:

[I]: *Does the final result of the learning designs in Moodle maintain the pedagogical essence well enough to remain usable by their original authors (faculty)?*

According to the method followed, the *Issue* is split into a set of more concrete *Topics* with the aim of helping researchers to illuminate it. Following the same rationale,

each *Topic* is operationalized in a number of *Information Questions* that give insight on each topic. This way, a set of *Information Questions* helps in the understanding of a particular *Topic*; a set of *Topics* illustrates the *Issue*, that functions as conceptual organizer of the evaluation, helping to better understand our *Evaluand*. Figure 4 shows *Topics* [T] and *Information Questions* [IQ] defined and it illustrates the relation between *Information Questions*, *Topics*, *Issue* and *Evaluand*.

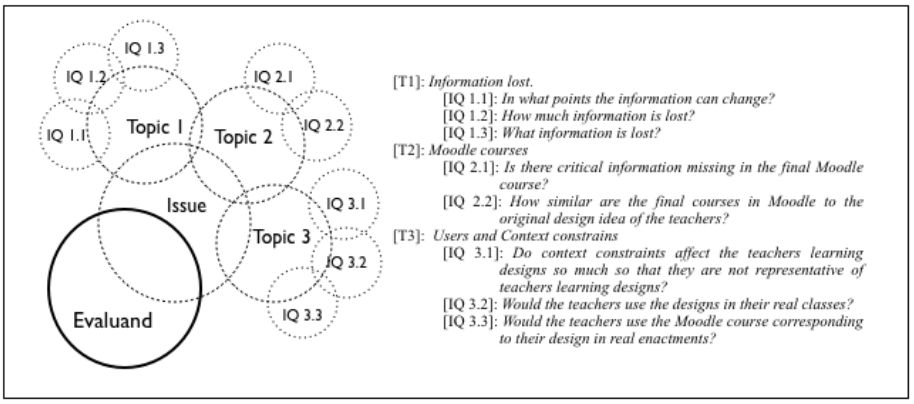

Fig. 4. Topics and Information Questions

3.3 Results and Evidences

Regarding the *Information lost* [T1], teachers' designs were structured in characteristics (or facets). 47 facets were detected in the 37 designs:

Design general facets:

Title, author, teacher, design date, context, description, collaborative pattern, general objective, objectives, competences, number of students, number of sessions, grouping, total duration, previous requirements, routines, backup plan, ICT tools, total temporal extension, contents, face-to-face/remote duration, subject, resources, work method, student estimated attendance.

Facets in the sequence of activities:

Title, session, session duration, task duration, duration, face-to-face/remote, pictures/drawings, actor, task description, number of students, grouping, student tasks, teacher tasks, instrument/artefact/resource, non-ICT tools, ICT tools, time between sessions, routines, objectives, phase/level, deliverable, physical space structure.

We calculated the occurrence of these facets, and we analyzed what information is lost and where, by comparing the facets with the data models and user interfaces of the different ICT tools involved (*WebCollage*, *GLUE!-PS* and *Moodle*).

The analysis of the translations carried out [Content] shows that most information is lost in the tool used to generate a computerized script from the teachers' designs, (*WebCollage*, in our case). Figure 5 shows the facets with occurrence over 40% (i.e. that appear in more than 40% of the teachers' designs), and whether they are supported (green) or not (striped red) by each of the ICT tools used in this concrete instance

of the CSCL script life-cycle. In addition, Figure 5 shows that most of the facets *not* supported by *WebCollage*, are not supported either by the rest of tools (*GLUE!-PS* and *Moodle*). Interestingly, we found out that 47,37% of the facets identified in the original designs (with the aforementioned 40% occurrence) would be lost in the resulting courses in *Moodle* (red in Figure 5) [Content], since they were not present in one or more of the tools in the involved life-cycle. One would expect that this loss of facets with high occurrence should have a great effect on the final result, since they seem to be important to the teachers (due to their high occurrence). Such lost facets mostly relate to learning design *general characteristics* (context, description, number of students, total duration and subject), information about *time and sessions*, and information about whether the task is *face-to-face or remote*. On the topic of *Moodle courses* [T2], it would be interesting to uncover whether teachers notice the loss of critical information or not [IQ 2.1]. Triangulating the quantitative data from the aforementioned facet analysis, with quantitative and qualitative data gathered from teachers feedback, we found out that although several facets are lost in the translations [Content], most teachers don't miss critical information in *Moodle* implementation of their designs [Quest]. E.g., one teacher commented "*I think everything is included but when I compare it with the one (Moodle) I use in my course, my structure is different, maybe because of the limitations of the Moodle configuration of the University of Valladolid* [Quest]". Another teacher said: "*[to the question: did you miss something from the design?] No, I don't think so […] Maybe the description of some of the tasks, or some missing questionnaire […] the general activity schema is well developed* [Interview]".

Fig. 5. Facets with occurrence in more than 40% of the analyzed learning designs, as well as ICT tools that support them (in green) or not (in red ruled), and facets lost in the way to Moodle in one or more ICT tools (red).

Most of the teachers (67% [Quest]) gave positive feedback about the similarity of the final course in *Moodle*, when compared to their initial idea [IQ 2.2]. Such positive feedback was confirmed in the qualitative answers in [Quest] where, for instance, one comment was "*Yes (it is similar), although I think it would be good to have a graphical sketch* of the design/pattern used [Quest]", and in the interviews ("*[Do you think the course represents the design faithfully?] More or less it does. The activity structure was correctly built […] I think there is a problem with one activity, which should be individual and was in group* [Interview]"). Some teachers reported some misinterpretation in the design: "*[to the question: what did you think about the generated course?] There was a small problem […] you interpreted that there were 8 documents, but it was the same one for all the class (in the end, it seemed that s/he assumed that the 8 links referred to different documents, not to the same one)* [Interview]".

About *Users and Context constraints* [T3], results show that the context, tasks and indications of the workshop imposed constraints to the designs made by teachers [IQ 3.1]. 76% of the teachers answered in [Quest] that they changed their way on designing learning activities. This was confirmed by the questionnaire qualitative data. For example, a teacher wrote that "*[…] work in groups is something I had considered before, but I had rejected the idea because of the complexity […]* [Quest]", while another commented "*[…] never limited myself to a collaborative work pattern (I had no idea they existed!)* [*Quest*]", and another wrote "*[…] Another important change is the introduction of ICTs in the class for the work in groups* [Quest]".

Although it seems that the teachers changed their way of designing (which is expected given that the workshops dealt with learning how to do learning design), it is interesting that most of them would use the workshop learning designs in real practice [IQ 3.2]. 75% answered they could use the design in practice [Quest]. This finding is also confirmed in the qualitative answers of [Quest], where, for example, one teacher comments "*It is something I can do. I see that it is feasible to include this kind of activities progressively […]* [Quest]". On the other hand, some teachers think that using collaborative designs in real practice is difficult: "*At this moment I cannot apply activities like these because of program limitation and available time* [Quest]".

Also, most of the teachers (67% [Quest]) would use the *Moodle* course corresponding to their design in real enactments [IQ 3.3]. This element was confirmed with the qualitative data in questionnaire and interviews. An example is the comment of a teacher: "*Yes [I would use it], it would save time, although it would require tuning* [Quest]". Other teacher commented "*[to the question: would you use your design in real practice immediately?] This same thing I designed […] I think I could do it […] there were a couple of technical problems that I would have to work out […] I will probably try this* [Interview]". Most teachers confirmed in interviews that students would be able to use the *Moodle* course: "*[to the question: would your students be able to use it?] I think they would, Moodle is not the problem […] the problem is the tedious work of forming groups, creating documents, reforming groups…* [Interview]". Also, some teachers did not like the appearance of the course in *Moodle*. For instance, a teacher said "*[to the question: would you be able to use it?] I think it has to be simple […] I don't see it very complex, it is simple, but [...] It is not appealing*

to the eye […] it is the presentation […] I did not expect it to be like this (the list of links activities presentation in Moodle) [Interview]"). Another commented: "*[to the question: would you use this design in real practice] The Moodle as it is now […] it limits too much, is not very interactive* [Interview]".

Table 2 shows a summary of the findings, and the supporting data sources.

Table 2. Main findings in the evaluation

Topic	Finding	Support data
[T 1]	47,37% of facets with an occurrence over 40% are lost in the resulting courses in *Moodle*.	[Content]
[T 1]	42,11% of facets with an occurrence over 40% are not supported by *WebCollage*, same % are not supported in *GLUE!-PS*, and 36,84% are not supported by *Moodle*.	[Content]
[T 2]	Not much critical information lost in the final *Moodle* course	[Content][Quest] [Interview]
[T 2]	Most of the teachers gave positive feedback about the similarity of the final course in *Moodle* to their initial idea	[Quest][Interview]
[T 3]	The context, tasks and indications of the workshop imposed constraints to the designs made by teachers	[Content][Quest]
[T 3]	The differences were mainly in the using of collaborative activities and patterns, and ICT tools (the focus of the workshops)	[Quest]
[T 3]	Most of teachers would use the learning designs in real classes	[Quest][Interview]
[T 3]	Most teachers would use the *Moodle* course in real enactments	[Quest][Interview]

4 Discussion

We have found evidences showing that, in the particular situation studied, with its inherent constraints, most of the teachers consider that the final result of their learning designs in *Moodle*, although not exactly like their initial idea, is similar enough to be used. Most of the opinions were positive about the course in *Moodle*, and they did not notice either too much or too critical information loss, even though the quantitative study of the designs content showed that a considerable amount of information was lost in translations from initial designs to *Moodle*.

Our first finding, the constraints imposed on the teachers' designs by the context of the study, was somehow expected. The study was conducted in the context of two professional development workshops, and participants were being trained in designing collaborative activities supported by ICT. Given that the designs generated by participants were not representative of their own designing style so far, it was important to obtain evidences of the feasibility of the generated designs to be used by the teachers in real practice after the workshop. The results in this regard are promising, due to the positive feedback in quantitative ratings in questionnaire and qualitative answers both in questionnaires and interviews. Also, qualitative data in the questionnaire shows evidences that the main changes in the designs were the inclusion of col-

laboration, and ICT support in the activities. Such indications of produced learning design feasibility show that this research is highly relevant for the TEL/CSCL field. However, the reduced scope of the presented study, with very similar contexts and constraints, is the main limitation of the present work. We have studied only a particular case, with several pedagogical constraints and imposing certain restrictions to the creativity of participant teachers. In any case, this is an unprecedented case of end-to-end life-cycle study, and thus, other studies in other contexts are a clear line of future research.

As we mentioned in Section 2, information lost in the CSCL script life-cycle can take place by the action of human and software agents. The present work is more slanted to the technological side, being more focused in data translations than in the pedagogical side of the designs. Also, human and software agents were the same in both workshops, which is another limitation of the study. Future work including different agents and comparing results with other technological solutions, and other human agents interpreting results is thus another clear path to extend this research.

The chosen technological solution is another interesting feature of the study, since it allows to complete the CSCL script life-cycle in an automated way, going from multiple different design authoring tools (or learning design languages), to multiple different VLEs (by using the GLUE!-PS architecture [13]). This technological solution imposes further data losses that other solutions (which may directly translate from an authoring tool to a VLE [8,19,20]) may not incur. However, the positive results of the study, even in this unfavorable technological setting, are promising for these kinds of solutions trying to apply learning design to mainstream VLE educational scenarios.

Probably the most striking result of this study is that, in the learning designs included in the study, almost 50% of the facets identified (with an occurrence in more of 40% of the designs) were lost in the translation. Despite this fact, teachers didn't seem to notice, in general, a loss of critical information. Most facets could be considered to refer to contextual descriptions, although some of them seemed significant *a priori* (like time or sessions information). Thus, further research regarding the relevance of the design facets for the usability in the real practice using widespread VLEs should be undertaken. More specifically, a deeper study of the final result (i.e. the deployed *Moodle* course) should be performed by the original authors (e.g., using the *Moodle* course in a real class), in order to detect any particular relevant facets that may had gone unnoticed by the teachers in the visual review of the *Moodle* courses.

5 Conclusions

The results discussed above are limited to the context and scenario of the case studied, but this kind of results could be of high interest to researchers working on the support of CSCL scripts, and can motivate further research in this field. ICT tools supporting the CSCL script life-cycle can be improved taking input from similar studies as, for instance, the ICT tools involved in the present research could be enhanced

to include some of the lost facets with high occurrence detected in content analysis (e.g. time or sessions information).

Also, further research can be conducted considering the combination of ICT tools that GLUE!-PS is able to support, studying the pedagogical effects of real enactments in different VLEs and Web 2.0 platforms (e.g. Blogs or Wikis), and using different learning design tools. Moreover, the effect of human agents is also an interesting research line that this work could motivate. Studying how the interpretation of a design in the different life-cycle phases affects the pedagogical essence, or the interpretation and formalization processes themselves when using a particular ICT tool, or even how changes in the learning design (due to human or computer agents) affect the reusability of a learning design. All those could be questions for further research that are relevant not only for the learning design field, but for TEL practice as a whole.

Acknowledgments

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