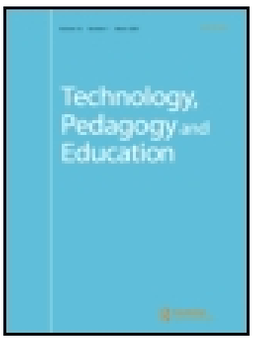

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Supporting and representing Learning Design with digital tools: in between guidance and flexibility

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ABSTRACT

The research field of Learning Design (LD) has been active for some time now, but several questions remain open for the scientific community. In particular, the article tackles issues that have been core concerns in LD over the years: (1) how to support the different phases of the LD process; (2) what representations should be used in the various steps; and (3) to what extent should digital LD tools be structured or flexible, either guiding the teacher/designer or leaving them free to pursue their own design path and style. The authors investigated these open questions through an LD tool called the Pedagogical Planner. This tool has been evaluated in authentic contexts with the goal of providing input for the ongoing debate. Evaluation has focused on the perceptions and actual usage by teachers, generating significant evaluative data to be used as a spur for further reflection on LD.

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Learning Design; representation; conceptualisation; authoring; implementation

Introduction

Over recent decades, researchers in the Learning Design (LD) field have been striving to facilitate innovation in teaching and learning processes through effective support for the complex task of conceptualising and elaborating activity plans that can be enacted, shared and repurposed (Conole, 2012; Mor & Craft, 2012; Persico & Pozzi, 2015). Following different conceptual approaches, researchers have proposed and tested a range of different methods and technological tools, with varying degrees of success (Celik & Magoulas, 2016; Persico et al., 2013; Persico, Pozzi, & Goodyear, 2018; Prieto et al., 2013).

In spite of these efforts, teachers' adoption of LD tools and approaches in their everyday practice is generally reported to be low (Berggren et al., 2005; Dagnino, Dimitriadis, Pozzi, Asensio-Pérez, & Rubia-Avi, 2018; Griffiths, Goddard, & Wang, 2011; Mor, Craft, & Hernández-Leo, 2013; Mor & Mogilevsky, 2013; Neumann et al., 2010; Prieto, Tchounikine, Asensio-Pérez, Sobreira, & Dimitriadis, 2014).

One of the main reasons behind low adoption lies in the fact that it seems highly challenging to provide adequate support and effective technological solutions for a process that is complex in nature, sometimes systematic, sometimes creative, and in any case not always reducible to a number of predefined steps (Masterman, 2013; Winograd, 1996).

Among the issues still on the table is the difficulty in providing support for the various design phases, each one being characterised by specific needs and purposes (Celik & Magoulas, 2016).

Another difficulty often highlighted by the research community is to define languages able to support the LD process in its various stages and at the same time effectively represent the

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complexity of the final output of the design process (Dalziel et al., 2013; Pozzi, Asensio-Pérez, & Persico, 2016). These difficulties are at the root of the debate about whether a single tool can adequately cover all LD phases and needs or whether a set of tools would provide a more suitable response to the different needs that might arise (Masterman & Manton, 2011; Mor, Craft, & Maina, 2015).

Moreover, digital LD tools need to have sufficient flexibility to support creativity and to accommodate teachers' personal design paths and styles, while at the same time bring structure and guidance to the Learning Design process, especially for less experienced designers (Celik & Magoulas, 2016; Masterman & Manton, 2011).

As part of their contribution to this broad and complex debate, the authors have proposed an LD tool called the Pedagogical Planner (PP) and have implemented in the tool specific features aimed to address some of the issues raised above. In the present study, the authors describe these features along with their evaluation, with the aim to investigate the following three research questions:

RQ1: How should the different LD phases (characterised by different needs) be supported?

RQ2: What kind of representations best fit teachers' needs in the various stages of the Learning Design process?

RQ3: To what extent should digital tools provide 'structured' or 'flexible' support ('structured' in terms of being able to provide guidance through the design process; 'flexible' in terms of being able to support a multiplicity of routes, styles and purposes through the design process)?

While in this section the authors have introduced the LD research field as a whole and have provided an overview of the main aspects currently being discussed by the research community to provide the general framework of this study, in the following section (Background) the authors focus more specifically on the concepts addressed in this article (i.e. support to LD phases, LD representations for the various design stages and flexibility vs. structuredness of LD digital tools). Then, the article proceeds with a description of the Pedagogical Planner tool, and then a report is given on a recent round of field-testing. Finally, the authors discuss the results obtained from this evaluation in an effort to answer the three research questions mentioned above.

Background

This section is intended to provide the theoretical background for the three research threads explored in this study, i.e. support to LD phases, representations for the various design phases, and tension between structuredness and flexibility of LD digital tools.

As Winograd (1996) and Masterman (2013) pointed out, conceiving and planning flows of educational activities is a complex process which does not necessarily follow predefined steps. In an attempt to reduce this complexity to a more manageable level, some researchers have identified 'phases' or 'stages' in the LD process. Those proposed by Beetham (2008), for example, are creating a design, instantiating/setting up the learning environment, realising/running the design and reviewing/reflecting on the design.

More recently, Pozzi et al. (2016) have identified the following phases:

- conceptualisation of the design idea (defining learning objectives, identifying content area/s to be addressed and choosing the most appropriate pedagogical strategies);
- planning and authoring the flow of activities (including association of the educational resources and tools that learners are to use);

- delivery of the resulting design (from a single activity to a whole course) and enactment with learners through implementation within some kind of (digital) environment such as a Learning Management System (LMS).

The definition of these phases derives from a European research project called METIS, funded within the European Community's Lifelong Learning Programme. METIS brought together a number of researchers exploring different avenues in LD, allowing them to compare approaches, find areas of convergence and, on that basis, devise new solutions. One such outcome was the identification of the above core LD phases, which formed the backbone for the project's subsequent development of an LD platform (see below for further details on this) (Asensio-Pérez et al., 2017). Accordingly, this article adopts the categorisation and terminology agreed in METIS.

As already mentioned, in the last decade researchers working in the LD field have sought to propose digital tools capable of supporting one or more than one of these phases. An interesting review, timeline and categorisation of these tools are provided by Celik and Magoulas (2016), encompassing authoring and sharing tools; assessment planners and learning analytics; reflection tools and pedagogical planners; delivery tools; and repositories.

Without any ambition to be exhaustive, to better contextualise the discussion set out in this article, it is worth noting here some of the main LD tools specifically designed to support pedagogical reflection and foster teachers' creativity in conceiving new educational paths. Examples include the Course Map (Conole, 2012), the 4SPPIces approach (Pérez-Sanagustín, Santos, Hernández-Leo, & Blat, 2012), the 4Ts model (Pozzi & Persico, 2013) and Persona Cards (Chacón-Pérez, Hernández-Leo, Mor, & Asensio-Pérez, 2015), which are all examples of tools aimed to support conceptualisation of new designs.

Other tools, by contrast, address activity planning and delivery to learners (Earp, Ott, & Pozzi, 2013; Muñoz-Cristóbal, Prieto, Asensio-Pérez, Jorrín-Abellán, & Dimitriadis, 2012; Persico & Pozzi, 2015; Pozzi et al., 2016). Examples are Collage (Hernández-Leo et al., 2006), WebCollage (Villasclaras-Fernández, Hernández-Leo, Asensio-Pérez, & Dimitriadis, 2013), CADMOS (Boloudakis, Retalis, & Psaromiligkos, 2018), OpenGLM (Derntl, Neumann, & Oberhuemer, 2011), EDIT2 (Sobreira & Tchounikine, 2012) and edCrumble (Albó & Hernández-Leo, 2018), which are mainly intended for authoring designs and packaging them for delivery to learners. Many of such authoring tools draw on the IMS-LD specification (IMS Global Learning Consortium, 2003), which was developed to allow the representation of designs in a machine-interpretable way.

Other LD applications such as LAMS (Dalziel, 2003) and CeLS (Ronen, Kohen-Vacs, & Raz-Fogel, 2006) have been developed not only to facilitate the authoring of designs, but also with particular concern for allowing these to be run online. Indeed, LAMS can be used as a stand-alone e-learning application in its own right, or can be integrated into popular LMS as a sort of plug-in providing advanced LD capabilities. CeLS, on the other hand, is dedicated specifically to the design, implementation and management of learning activities inspired by the principles of social constructivism.

FROG (Håklev, Faucon, Hadzilacos, & Dillenbourg, 2017) is an editor for collaborative scripts, although its main functionality is about run-time management (orchestration) and data analytics. Similarly, there are other systems that include LD 'editors' that are tied to a deployment environment (e.g. WISE; Linn, Clark, & Slotta, 2003). Among the tools that build on data analytics, there is also LA4LD (Schmitz, Scheffel, van Limbeek, Bemelmans, & Drachsler, 2018), which enables teachers and students to get on-demand feedback in such a way to improve the design during the runtime of a course.

Finally, among the tools more oriented to design sharing, LdShake can be mentioned (Hernández-Leo et al., 2011), which is devoted in particular to the sharing and repurposing of Learning Designs, and the Learning Designer (Laurillard, Kennedy, Charlton, Wild, & Dimakopoulos, 2018), which is oriented to both the support of good pedagogy design and the sharing of effective design practice.

Along with all the above-mentioned tools, which originated in the research sector, interestingly some 'commercial tools' related to Learning Design can be found.[1] Nonetheless, an exhaustive description of these commercial tools is beyond the scope of this article.

This proliferation of tools that cover only part of the spectrum of LD phases is sometimes seen as a sign of fragmentation in the LD field (Mor et al., 2015). Some researchers have suggested to take advantage of this variety and richness, by using various tools, instead of striving to find one single tool that fits all purposes (Masterman & Manton, 2011; Mor et al., 2015). In this latter vein, a number of the above-mentioned tools have recently been integrated into the ILDE (Integrated Learning Design Environment) (Asensio-Pérez, Dimitriadis, Hernández-Leo, & Pozzi, 2015; Hernández-Leo et al., 2018), an aggregated LD platform developed as part of the METIS project introduced earlier. The main aim of the project was to tackle dispersion in the LD field by building a one-stop shop offering access to leading LD tools, which designers can pick and choose from depending on their needs. While the project generated positive results in terms of teachers' acceptance of the ILDE (Asensio-Pérez et al., 2017), additional effort is required to broaden and consolidate acceptance of ILDE among target users, and to ensure it has a significant impact on teaching practice.

The above-mentioned examples include 'structured' tools, i.e. those imposing predetermined steps in the quest to guide the design process, as well as others that are more 'open' and flexible, i.e. intended to accommodate different design routes and styles.

In addition, they implement a wide variety of different representation forms (Dalziel et al., 2013), but none of the current notational forms seems to be capable of accommodating the whole range of needs, in particular that of making a design readily understandable to others (colleagues or learners) and machine readable at the same time (Masterman & Manton, 2011). Indeed, Pozzi et al. (2016) argued that, given the different priorities involved, a 'one size fits all' representation mode is not really practicable. Rather, they advocate the use of multiple representations to cover the different LD phases, provided that the transition from one to another is smooth for the user.

Masterman and Manton (2011) examined representations teachers might need during the design process to support creativity and conceptualisation of new design ideas. These authors advocated that, in this particular phase of the process, digital mind maps could be highly supportive, as these resonate with the manual mapping teachers tend to use when they conceptualise without any digital support.

Further contribution to the debate has come from the efforts numerous researchers have made to observe and better understand teachers' actual design practice (Bennett, Agostinho, & Lockyer, 2015; Celik & Magoulas, 2016; Masterman & Manton, 2011; Oliver, 2006). This has been done on the assumption that the better we understand teachers' current practice, the more effectively LD tools will be in supporting them. According to these researchers, any LD tool should reflect what teachers traditionally do when they design (Masterman & Manton, 2011) and be grounded on teachers' actual practice (Masterman, Walker, & Bower, 2013).

As described in the following sections, all these aspects are still open challenges and have been considered during the development of the Pedagogical Planner, which is illustrated in the section below. In the Pedagogical Planner, the authors have implemented specific features to provide possible solutions, and in this article, the data coming from the evaluation of these features are used as a spur for further reflection regarding the three research questions already specified in the Introduction.

The Pedagogical Planner

The design and development of the Pedagogical Planner represents a long-term undertaking carried out over a decade and spanning various research projects (Bottino, Ott, & Tavella, 2011; Pozzi, Ceregini, Dagnino, Ott, & Tavella, 2015). The description of the iterative and user-centred approach adopted to develop the tool is beyond the scope of this article, and is reported in Earp et al. (2013). Without any ambition to (re-)describe in detail the design and development process, here it is

important to stress that the tool is grounded on teachers' actual practice. Its design and implementation were based on direct observation of teachers' design practice, leading to the formulation of user requirements and the consequent development of functionalities resonating with teachers' traditional ways of doing things, as strongly recommended by various authors (Bennett et al., 2015; Celik & Magoulas, 2016; Masterman & Manton, 2011; Oliver, 2006).

Moreover, the overall design and development process was also informed by theory: the research team drew especially on those studies in the literature where teachers' LD habits and procedures were investigated (Bennett et al., 2015, 2008; Norton, Richardson, Hartley, Newstead, & Mayes, 2005).

It is important to underline that – being rooted in various projects – the tool was developed taking into account constraints and needs of different contexts, including school and university. The good results obtained in the various evaluation sessions carried out through the years (Bellotti et al., 2012; Ott, Dagnino, & Pozzi, 2015) suggest there is good potential as far as transferability is concerned. However, this is beyond the scope of this study, whose target context was school education, as will be further illustrated later on.

The rationale behind the tool is to support teachers in their design activities, without orienting them towards a specific learning theory. As Laurillard et al. (2013) highlighted, design tools should support the way teachers approach their normal practice, so the authors deliberately proposed a 'neutral tool', in such a way that teachers could be free to choose any pedagogical approach.

In the following, the authors list the main requirements that have been taken into account during the development of the PP. These represent the authors' response to the gaps that have emerged in the literature (highlighted in the section above), as well as to the needs that emerged from teachers' practice:

- The tool should be able to support the main LD phases (Conceptualisation, Authoring and Implementation) and allow a smooth passage and iterative switch (if needed) among the phases (Celik & Magoulas, 2016).
- Considering that these phases cover different needs, the tool should be able to support each of them, by providing specific representations able to accommodate the various design needs (Pozzi et al., 2016).
- In particular, during Conceptualisation, the phase in which the designer's creativity is most prominent, teachers normally use graphical representations such as mind maps and so the tool should be able to support this feature (Masterman & Manton, 2011).
- The tool should allow conceptualisation of new designs starting from consideration for the type of cohort of students that will be targeted, the learning outcomes they will need to reach and the main contextual constraints (Bennett et al., 2015, 2008; Norton et al., 2005).
- Given that the Authoring phase is where the designer brings order out of the (possible) chaos of the Conceptualisation phase, and where conceptualisation ideas crystallise in the form of an ordered sequence of activities, the tool should be able to represent learning activity flows, possibly by offering multiple types of activities so that a rich learning path can be presented.
- The tool should offer both flexibility and structure, by allowing partial usage and non-systematic ways of proceeding, but also by providing guidance to those who need to be scaffolded (Celik & Magoulas, 2016; Masterman, 2013; Masterman & Manton, 2011; Winograd, 1996).

These features have been integrated into the PP, which the authors shall now illustrate and whose evaluation will be presented later on in the article.

The PP[2] is a scalable cross-browser web-based application developed in PHP, MySQL and Javascript. As already mentioned, it is designed to cater for the three LD phases and in this sense can be regarded as being subdivided into three corresponding areas: (a) the Conceptualisation area; (b) the Authoring area; and (c) the Implementation area (allowing delivery in an LMS).

Hereafter, the three areas are described in order of appearance in the LD cycle. In the PP Conceptualisation area, the designer is called on to consider foundational elements and to describe

each one either by entering a short textual description or by selecting from a set of predetermined values. These elements are grounded in the LD literature (Bennett et al., 2015, 2008; Norton et al., 2005) and comprise:

- the target 'Population' – the main characteristics of the population addressed, such as age and possible prerequisites such as required content knowledge or skills;
- the learning 'Context' – the learning situation/environment where the educational intervention will be carried out, regarding type of context, constraints (if any), setting and time frame;
- the 'Content domain' – the general content areas to be addressed, with the possibility of building a mind map of those contents (see Figure 1);
- the 'Objectives and Metrics' – the main learning goals the intervention is meant to reach, plus the criteria for monitoring and evaluation;
- the 'Tools' – the tools and the features to be used during enactment with learners.

One of the most distinctive features of the PP lies in the possibility to engage in conceptualisation using textual representation or graphically, using a mind map (see Figure 1). The designer can also jump from one representation to the other and there are no mandatory fields, nor predetermined order that needs to be followed. So while the tool proposes design aspects that are potentially useful for less experienced designers to consider and different ways to express these, it does not force users to include these in their design. Partial, non-sequential and fuzzy use of all the fields in the PP is always possible, and this is especially important in Conceptualisation, the most creative phase of the LD process.

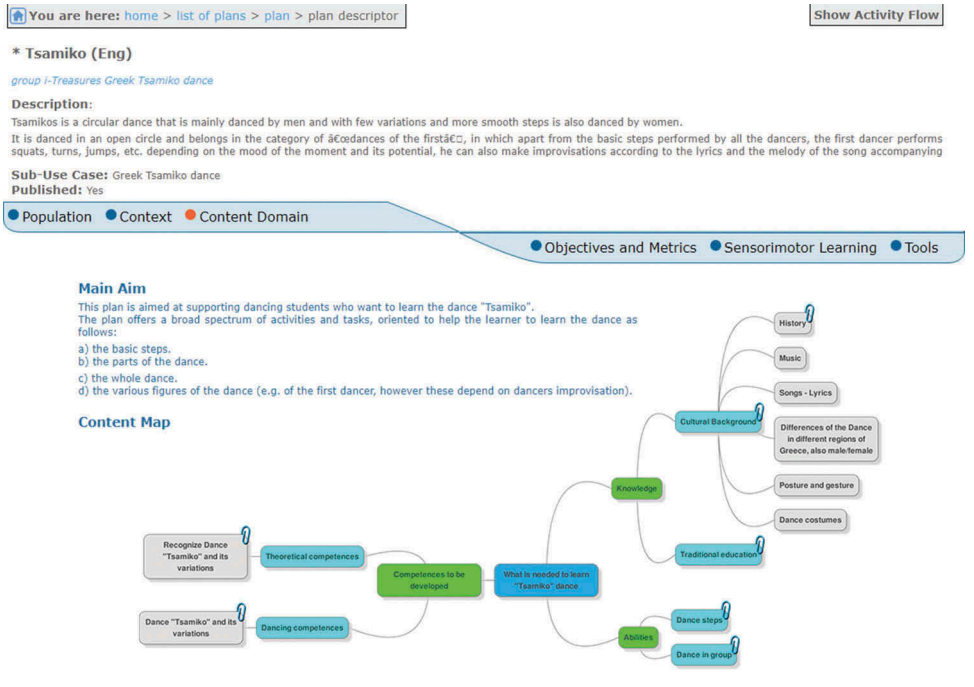

Figure 1. The PP Conceptualisation area – mind map.

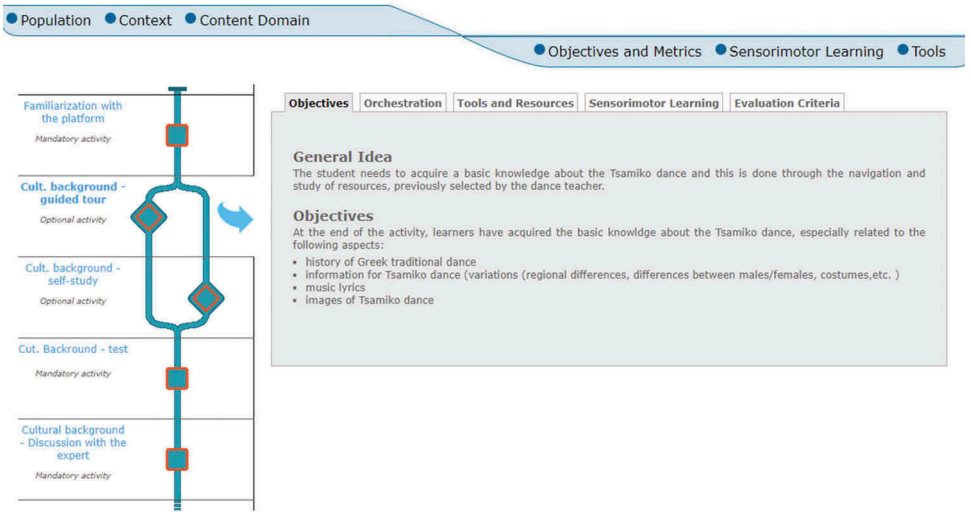

Figure 2. The PP Authoring area.

In principle, the LD process could begin and conclude with the Conceptualisation phase, whereby the designer engages in LD simply to clarify and express his or her ideas and intentions.

But the Authoring phase, which includes specification of activity flows and any related tools/resources, is usually worth undertaking as well, especially when the designer wants to share his or her design with others and/or is considering delivering it in a digital learning environment. Figure 2 shows the expanded Authoring area in the PP, with an interactive graphic representation of the activity sequence on the left and, in the middle, the activity description, which unfolds when clicking on the corresponding activity in the left-hand graphic.

Designers using the PP can define each of the activities in their plan by inputting a short textual description under four proposed headings: Objectives (the learning objectives of that specific activity); Orchestration (the foreseen characteristics of the setting and any instructions for students); Tools and Resources (educational tools and resources learners are to use during the enactment phase, with the possibility to link or upload digital assets); Evaluation Criteria (criteria for evaluating the effectiveness of the activity).

The tool allows the designer to define activities as either mandatory or optional, and these have a different graphic representation in the flow diagram. The activity flow can be sequential, random, and can include multiple pathways. This allows a certain degree of personalisation, i.e. the designer can propose different activities to different learners (or groups of learners) pursuing the same set of objectives. More specifically, the following options are possible: single activity (square symbol if mandatory, diamond if optional); ordered sequence of activities; non-ordered sequence of activities (cloud symbol); path branching; group branching (Figure 3).

Again here, it is important to underline that there are no mandatory steps the designer has to follow; (s)he is free to jump from one design field to another, and even to jump between any part of the Conceptualisation area to any part of the Authoring area. At the same time, however, the way the PP is structured and presented constitutes a form of basic scaffolding that less experienced designers may find helpful when seeking to come to grips with LD.

Once the Conceptualisation and the Authoring phases are completed, the designer can move on to the Implementation phase, if so desired; this is activated by clicking the 'Send to the LMS' button. Implementation of the plan into a format suitable for delivery is performed by a special application called Glue!-PS (Group Learning Unified Environment – Pedagogical Scripting) (Prieto et al., 2013), which is integrated into the PP.

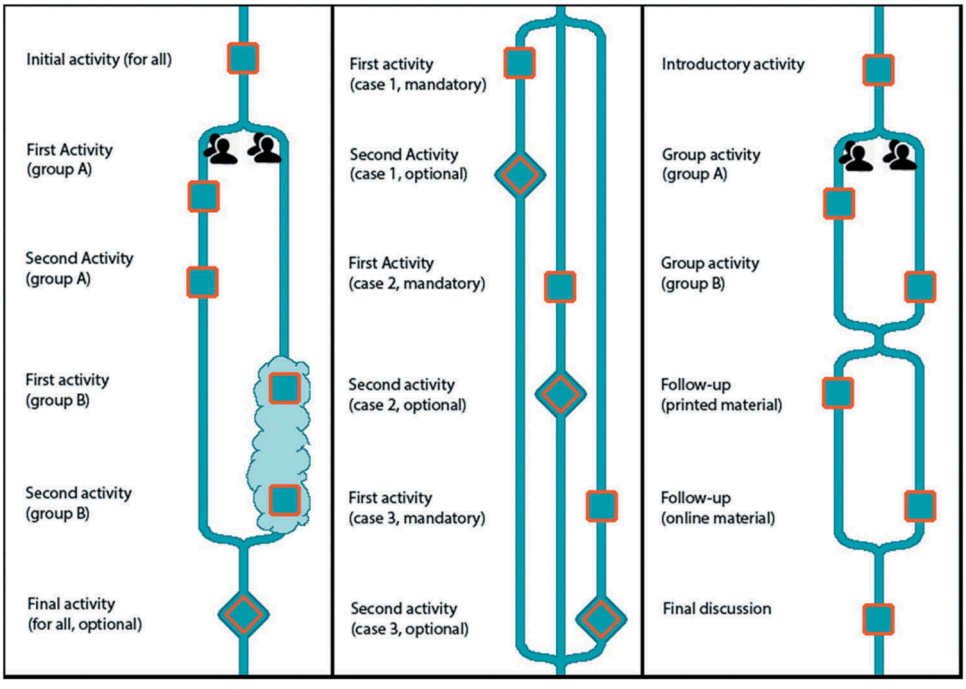

Figure 3. Examples of PP activity flow diagrams (with different branching options).

Glue!PS automatically configures the technological platform to be used for enactment of the LD (e.g. an LMS such as Moodle) according to the teacher instructions expressed in the previously authored, computer-interpretable design. Designers can use the Glue!-PS Graphical User Interface (GUI – see Figure 4, centre) to (1) assign students to the different groups envisioned in the authored design; and (2) specify which ICT tools (offered by the LMS) students are to use during enactment in the different activities. Finally, Glue!-PS automatically sets up and configures the target LMS in accordance with the specifications of the implemented LD (Figure 4, right).

From a technical point of view, in order to allow migration from the PP to the LMS when the design is ready, Glue!-PS translates the PP computer-interpretable internal representation of the design into what is called a 'Lingua Franca' (Prieto, Asensio-Pérez, Dimitriadis, Gómez-Sánchez, & Muñoz-Cristóbal, 2011), i.e. an intermediate LD representation capable of translating designs created with different authoring tools into courses run in different LMS.

Method of the PP evaluation study

As already mentioned, the authors carried out this study to evaluate the solutions that had been adopted and to explore teachers' reactions to the offered functionalities. The context, participants and procedure adopted in the evaluation are described in the following sub-sections.

In order to evaluate the PP functionalities, the authors decided to use the notion of 'acceptance', as defined in the Technology Acceptance Model. The reasons for adopting this particular model, rather than alternative instruments, were twofold: its wide-scale adoption in the educational technology field for predicting user acceptance of new technologies; and also because it seemed to fit well with the purposes of this study and had already been successfully used by the authors in similar contexts.

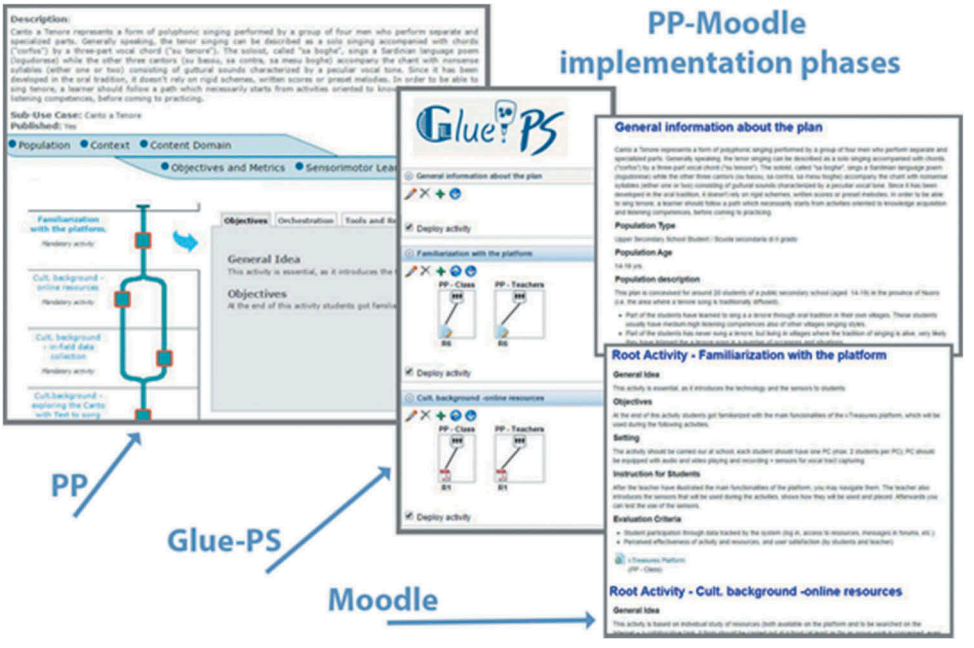

Figure 4. The passage from the PP, through Glue!-PS, to Moodle.

According to this model, the two main indicators that can predict acceptance of a technology are perceived ease of use and perceived usefulness (Davis, 1989). As further explained in the following, in addition to these indicators, the authors also decided to consider actual usage of the tool functionalities by teachers, as this could help better understand and possibly interpret teachers' perceptions.

Thus, the evaluation questions were formulated as follows:

EQ1: To what extent do teachers accept PP support for the LD main phases, namely Conceptualisation, Authoring and Implementation?

EQ2: To what extent do teachers accept PP support for different LD representations, namely natural language, digital mind maps and activity flow diagrams?

EQ3: To what extent might teachers be prepared to adopt the PP?

Figure 5 illustrates how the results obtained for each evaluation question contribute to the research questions mentioned at the beginning of this article. Specifically, the results obtained under EQ1 will provide inputs to the research question about how to support different LD phases and the corresponding needs (RQ1). EQ2 results will further discussion about the suitability of different representation forms (RQ2). Lastly, these results together with those obtained for EQ3 will spur discussion on the extent to which digital LD tools should be structured or flexible (RQ3).

Context and participants

The study was conducted in autumn 2016 as part of two Continuing Professional Development events held in Italy, one in Genoa and the other in Pescara. A total of 39 primary and secondary school teachers took part, 25 in Pescara and 14 in Genoa. Given that the two events were similar in terms of objectives and proposed activities, and involved very similar target populations, they are treated here as one and the same experience and the combined results are reported as a whole.

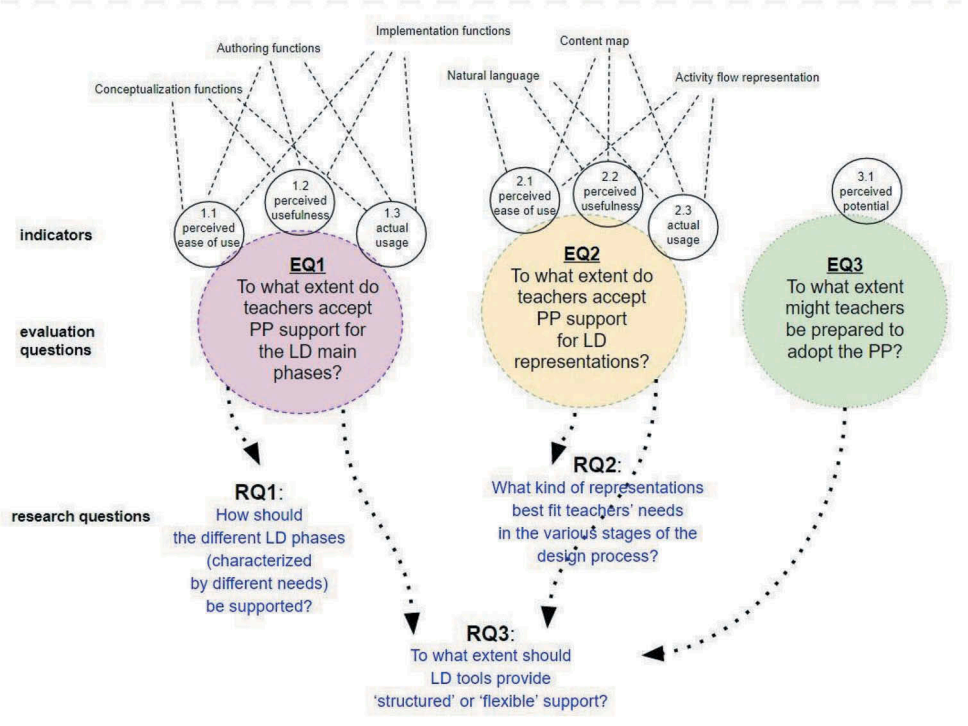

Figure 5. Research questions, evaluation questions and indicators.

The aim of these two-day training events was to introduce teachers to the Learning Design field, to illustrate the variety of available methods and tools, and to allow them to familiarise themselves with the Pedagogical Planner. Theoretical and informative sessions alternated with practical design activities in which teachers were asked to collaboratively incept a design idea, and then take fine-grained decisions to finally come to a complete design, ready to be delivered to students (that is, to conceptualise, author and implement designs, using the PP terminology). Therefore, in this study, teachers were targeted in their role of designers (Asensio-Pérez et al., 2017; Goodyear, 2015; Persico et al., 2018), although in principle the authors do not exclude professional instructional designers as eventual users of the tool.

In particular, teachers were divided in groups (12 groups in total) and were asked to design a learning unit for a specific context (that was, in most cases, their school). The unit could be interdisciplinary or focused on a single discipline, but all the participants were expected to contribute to the design, in terms of contents or ideas. As far as the granularity of the learning unit was concerned, it was suggested that the participants should conceive the overall structure of the unit (for a duration of about two weeks) and then go into the details of (i.e. they should author and implement) at least four to five activities composing the unit, as time constraints of the training session would probably not allow the cycle to be completed for all the activities.

The main learning strategy adopted during the practical sessions of the teacher training path was peer-based discussion, negotiation and collaborative production, through which teachers re-examined both their past and current practice.

As far as the participants' profile is concerned, due to the context and the time restrictions of the training, the authors only collected qualitative data. According to the gathered data, all the participants were quite experienced teachers with some experience of using digital technology in class. Despite this, they all defined themselves as 'novices' in the field of Learning Design and declared they had never been introduced to any digital LD tool before.

Procedure

At the beginning of the training sessions, participants provided informed consent regarding the data collection and use for research purposes only.

A questionnaire was administered at the end of each training event to gather data on teachers' profiles and their perceptions about the ease of use and usefulness of the various functionalities of the Pedagogical Planner.[3] The questionnaire included a set of closed questions to which participants were required to respond with a rating based on a Likert-type scale (from 1 = *low* to 5 = *high*). The questions were structured as follows: 'To what extent was it easy for you to conceptualise your design using the PP?'; 'To what extent was the PP useful for your design conceptualisation?', etc. Respondents were also offered the opportunity, if they wished, to write comments in open-text fields, explaining and justifying their quantitative answers with more qualitative information.

Moreover, system tracking data provided input on the actual use of system functionalities, in terms of number of designs created, number and types of fields completed in the various PP areas, number and types of activities created, number and types of fields filled in for each activity, etc. These data were also juxtaposed with the direct observation carried out by two researchers during the sessions. In particular, two researchers observed the teachers and took notes about the main difficulties met and questions posed while working. The notes were then analysed and discussed within the research team. The authors also analysed the 25 designs, which were collaboratively produced by the teachers attending the training events. Again in this case, the authors especially focused on number and types of system functionalities used to produce the final designs.

As to the data analysis, the quantitative data coming from the questionnaire were processed using SPSS software, whereas the qualitative data coming from the open questions were analysed with NVIVO software. More specifically, as far as the qualitative analysis is concerned, the coding process was carried out by two independent coders. After having agreed on two main categories of analysis (i.e. positive vs. negative expressions), the two coders selected a sample of answers (about 10% of the total answers) that was coded by both. The inter-rater reliability was calculated using the Holsti coefficient that resulted in 0.85 (per cent agreement 0.82). Disagreement was solved through discussion.

Main results

In this section, data concerning the three evaluation questions are presented.

EQ1: To what extent do teachers accept PP support for the LD main phases, namely Conceptualisation, Authoring and Implementation?

Table 1 provides an overview of the main results obtained about perceived ease of use and usefulness of the PP's main functionalities with Quartile 1, median and Quartile 4 given for each one. The median test was applied to establish whether teachers' evaluations diverged significantly from 3 in the 5-point scale.

As far as Conceptualisation is concerned, outcomes for both ease of use (Q1 = 3, Median = 4, Q4 = 4) and usefulness (Q1 = 3, Median = 4, Q4 = 4) are higher than 3 with a significant p (Exact $p < .001$ and = .019, respectively). A similar result was obtained for the Authoring functionality, with ease of use (Q1 = 3, Median = 4, Q4 = 4; $p < .001$) and usefulness (Q1 = 3, Median = 3, Q4 = 4; $p = .015$), both significantly higher than 3. While outcomes for Implementation are encouraging, they are not statistically significant either for ease of use or for usefulness.

Analysis of the actual usage of the various functionalities for Conceptualisation revealed that in all but three of the produced designs, teachers made extensive use of the Population and Context fields; they gave detailed descriptions of their prospective target, together with prerequisites for students, as well as the expected context of delivery, including information about the setting and

Table 1. Perceived ease of use and usefulness of the main PP functionalities.

	Q1	Median	Q4	Exact sig. (2-tailed)
Conceptualisation – ease of use	3	4	4	.000*
Conceptualisation – usefulness	3	4	4	.019*
Authoring – ease of use	3	4	4	.000*
Authoring – usefulness	3	3	4	.015*
Implementation – ease of use	2	3	4	1.000
Implementation – usefulness	3	3	4	.093

Note. *Significant: $p < 0.05$.

equipment necessary for carrying out the intended activities. This confirms findings in other studies (Bennett et al., 2015; Masterman & Manton, 2011) about the way teachers typically start conceiving a new design.

The authors also observed that all the designs contained a mind map: 17 designs out of the 25 included a map representing the contents, which was often a focus for discussion within the groups; in a couple of cases, the map was instead used to represent learning objectives.

In 13 designs, teachers defined the objectives of the overall design, and all the designs include indications about the prospective metrics to be used for student assessment. Fourteen designs also contained indications about the tools that should be used during the delivery.

As far as the Authoring functionalities are concerned, 15 designs included a representation of activity flow; these designs contained an average of 5.6 activities each. Teachers used the group branching option extensively (in seven designs activities are structured around three groups of students, while in four designs students are divided into two sub-groups). The remaining designs (4) are composed of ordered sequences of activities.

Within the single activities, usage of the fields was quite scattered; the teachers preferred to focus on the structure of the activity flow, rather than on the description of the single nodes. This may have been the result of time constraints imposed by the training events, which probably did not allow them to go into the single activities in any detail.

Implementation was the least used functionality, with only three designs being implemented in Moodle. Once again, time constraints were probably responsible. In any case, observation of the groups revealed that teachers perceived this stage as the most 'delicate' and 'technological', so most of them preferred to leave this passage for their more technical-minded colleagues in the group to deal with, rather than trying to do it themselves.

One last interesting behaviour that was observed regarded teachers' skipping from one field to another within the same phase, rather than jumping from one phase to another. In particular, in the Conceptualisation area, it was observed that eight groups (out of 12) used the mind map to trigger group discussion and then jumped to the text fields to fill them in, then came back to the map and then back to the text fields, and so on and so forth. The remaining four groups were more systematic in the way they approached the conceptualisation, by following the order of the fields proposed by the PP. The same happened within the Authoring area: while discussing the contents of one activity, five groups jumped to the graphical representation of the activity flow, modified it and then came back to the single activities, while the other three proceeded by authoring the flow first and then approaching the various textual fields of each activity.

EQ2: To what extent do teachers accept PP support for different LD representations, namely natural language, digital mind maps and activity flow diagrams?

As explained, the authors also gauged user perceptions of the different representation modes the PP makes use of. The main results are reported in Table 2.

As far as natural language descriptions are concerned, both ease of use (Q1 = 3, Median = 4, Q4 = 5) and usefulness (Q1 = 3, Median = 3, Q4 = 5) were rated significantly higher than 3 (Exact $p = .004$ in both

Table 2. Perceived ease of use and usefulness of the main PP representations.

	Q1	Median	Q4	Exact sig. (2-tailed)
Natural language – ease of use	3	4	5	.004*
Natural language – usefulness	3	3	5	.004*
Digital mind map – ease of use	3	4	5	.000*
Digital mind map – usefulness	3	4	5	.000*
Activity flow diagrams – ease of use	3	4	4	.000*
Activity flow diagrams – usefulness	3	4	4	.004*

Note. *Significant: $p < 0.05$.

cases). The same applies to mind maps, with rates for ease of use and usefulness (Q1 = 3, Median = 4, Q4 = 5; $p < .001$) significantly higher than 3. The response for activity flow diagrams was similarly positive: ease of use was rated as significantly higher than 3 (Q1 = 3, Median = 4, Q4 = 4; $p < .001$), as was usefulness (Q1 = 3, Median = 4, Q4 = 4; $p = .004$).

Data on usage of the representations have already been reported for EQ1 above and are not repeated here.

EQ3: To what extent might teachers be prepared to adopt the PP?

In addition to these data, teachers were also asked to give a rating about how useful they considered the PP to be as a whole, and also about its potential usefulness for colleagues. As Table 3 shows, while the median rates for these questions are encouraging (both Q1 = 3, Median = 3, Q4 = 4), only the Exact p concerning usefulness of the PP as a personal tool is statistically significant ($p = .035$).

Respondents also had the opportunity to explain their quantitative answers by responding to open questions. As already mentioned, these were analysed for occurrences of positive and negative expressions, as shown in Table 4.

Analysis of the open answers confirms 'usefulness' as the main perceived advantage brought by the PP.

In the following, the authors report some of the responses regarding PP usefulness:

> [The PP] lends homogeneity to the design and constitutes a first check of the validity of the design idea.
>
> It is useful, because it allows you to proceed in a less rough and episodic way.
>
> I think the system could also help to make the design clear to students.
>
> The Authoring phase is represented in a really effective way, as it helps rationalise things and it meets teachers' needs.

Regarding the aspects identified as needing further improvement, the graphical appearance of the PP is judged to be old-fashioned and not very appealing. The issue of Italian language support arose because, during the first of the two events, it was unfortunately not possible to provide the Help in the teachers' native language; this obviously caused some problems but was fixed in time for the second event. Moreover, according to the respondents, the bridge with Glue!-PS needs to be simplified (Implementation phase), as does the menu to access the activity flow options in the Authoring phase.

Table 3. Perceived usefulness of the PP as a personal LD tool and as a tool for colleagues.

	Q1	Median	Q4	Exact sig. (2-tailed)
PP as personal tool – usefulness	3	3	4	.035*
PP as a tool for others – usefulness	3	3	4	.405

Note. *Significant: $p < 0.05$.

Table 4. Occurrences of positive and negative terms in open responses regarding the PP.

Positive aspects	Number of occurrences
Useful	10
Complete	7
Clear	7
Intuitive	6
Flexible	4
Negative aspects	**Number of occurrences**
Graphical aspects to be improved	13
Help in Italian needed	6
Bridge through Glue!-PS to be simplified	5
Menu of the activity flow to be simplified	4

Discussion

This article illustrates the Pedagogical Planner (PP) in its present version, which is the result of a long-term iterative design process carried out across different contexts (Earp et al., 2013).

In the following, the authors examine the main results obtained from the evaluation round and make suggestions for the research questions outlined at the beginning of the article.

RQ1: How should the different LD phases (characterised by different needs) be supported?

Following the indications provided by Bennett et al. (2015), through the evaluation of the PP, the authors have tried to provide answers regarding the forms of support teachers find most acceptable and best fit their needs in the various phases of the design process. To do so, the authors have sought to ground the development of the tool on teachers' actual practice, as recommended by Masterman and Manton (2011) and by Oliver (2006).

The results of the evaluation confirm it is crucial that the functionalities provided by any LD tool resonate with teachers' established LD practices, as advocated also by Celik and Magoulas (2016). Moreover, the fact that most teachers in the study made extensive use of the Population and Context fields of the tool (23 out of 25 designs) suggests that the Conceptualisation functionality should allow teachers to focus on students' characteristics, as well as on contextual constraints and needs, as suggested by Masterman (2013). Moreover, the profuse use of the proposed graphical representation (25 out of 25 designs) to map mainly contents, confirms that mind maps can be an effective feature, which resonates with what Bennett et al. (2015) also suggested on the basis of their own observations of teachers. Thus conceived, the area of an LD tool aimed at conceptualisation can gain the appreciation of teachers, and the extensive use teachers made in this study of these functionalities confirms these are important forms of support in this creative step of the design process. At the same time, the authors have seen that each group of teachers followed its own particular way of proceeding; for example, some started from the definition of the target population, while others preferred to begin from expected learning outcomes. This possibility to choose from where to start the conceptualisation process, coupled with partial usage of fields, is thus a desirable affordance for LD tools.

As far as the Authoring functionalities are concerned, it seems that graphical representation of activity structure is a valuable feature, as suggested by the fact that most teachers included representations of non-trivial activity flows (average of 5.6 activities each), even including the use of branching features in seven cases. By contrast, textual description about each node (activity) in the flow has been less used in this context. This feature might be designated as mandatory only in cases where sharing is the main purpose, remaining an option where the purpose of the design process is more maieutic, i.e. for self-reflection.

The Implementation functionality was less extensively explored, and the data collected do not allow us to provide strong indications about how exactly to support this phase (only three designs

were implemented in Moodle). As suggested by observations and participants' opinions (see results in Table 4 in the previous section), the higher level of technical expertise required at this stage of the process may be somewhat intimidating for teachers and might affect their intention to further adopt the tool, so it would be useful to study more in depth how to simplify this step from a technical point of view. Furthermore, these results might call for a more in-depth reflection on the current level of teachers' digital competencies, given the issues that have been recurrently reported in the literature regarding the misalignment of the digital tool complexity and teachers' digital competencies (Aldunate & Nussbaum, 2013; Hatlevik, 2017; Prieto et al., 2014).

RQ2: What kind of representations best fit teachers' needs in the various stages of the Learning Design process?

Following what is suggested by Pozzi et al. (2016), the PP allows multiple forms of representation and supports integrated use of the various forms within single design stages, but also across the three main stages. This seems to be the right way to go, as this approach allows teachers to make the most out of each representation, without being forced to use representations that do not meet their needs.

Moreover, Mor et al. (2015) recommend adopting representation forms that are familiar to teachers, as well as possibly integrating graphical and textual representations, and making them machine readable. One possible way to implement this – as this study has suggested (see, e.g. results in Table 2 in the previous section) – is to integrate both the mind maps and the activity flow diagrams in the Conceptualisation and Authoring phases with textual information, although this should never be mandatory. Moreover, only when the designer wants to close the circle and proceed with the Implementation phase will (s)he need to provide further information in Glue!-PS (this time mandatory), in such a way that the design becomes machine readable and the LMS is automatically configured.

Regarding the mind-mapping function, it is worth stressing the fact that this was one of the recommendations made by Masterman and Manton (2011) as it is very familiar to the teacher population. To the best of the authors' knowledge, the PP is the only LD tool currently providing this kind of representation. Therefore, instead of providing original but 'proprietary' forms of representation, the authors think it is advisable to use mind maps, or similar, to support creativity and discussion within groups of teachers during the Conceptualisation phase.

RQ3: To what extent should LD tools provide 'structured' or 'flexible' support ('structured' in terms of being able to provide guidance through the design process; 'flexible' in terms of being able to support a multiplicity of routes, styles and purposes through the design process)?

Masterman and Manton (2011) pointed out the need for LD tools to support both flexibility and guidance. In the same vein, Masterman et al. (2013) suggested that LD tools should reflect different design approaches, being able, for example, to accommodate systematic ways of proceeding as well as more creative approaches, and supporting graphical representation along with more textually oriented approaches, etc.

The results obtained from the PP evaluation confirm these indications, as eight groups (out of the 12 groups) took advantage of the flexibility of the tool, by jumping from one field to the other(s), in a somewhat fuzzy way, while the remaining four groups followed a more systematic approach and let themselves be guided by the PP structure. By allowing partial usage of the fields, an LD tool can be used both to reflect a teacher's natural way of thinking and behaving, or even as a way to trigger a completely different approach (for example, to foster a smoother and more organic design experience for novice teachers or for teachers who usually design in a rough fashion, or to foster greater creativity in the case of teachers who tend to design in a regimented way). This evaluation of the PP also seems to suggest that not only is partial usage an important feature for an LD tool, but also a non-sequential and fuzzy use of the fields and areas, together with the possibility to change

'direction' at any moment, to jump from one part to another and to come back to previous phases – in other words, freedom and flexibility, without imposing predetermined ways of doing things.

Moreover, teachers need to be free to choose to use all the fields and give all the details, in case they are using the LD tool with sharing purposes, or they might want to provide less textual information and exploit the graphical representations only, in case they are using the tool with maieutic purposes (Olimpo et al., 2010). Besides, where the final aim includes delivery, teachers need to provide the finest grain of detail and structure, in such a way as to allow the (semi-)automatic configuration of the LMS for students.

At this point, the authors would also like to point out that the PP is pedagogically neutral as an LD tool, i.e. it does not embed any specific teaching/learning theory. This is a strategy recommended by Masterman and Manton (2011) as a way of ensuring transferability across different contexts of use, disciplines, perspective target populations, etc.

Moreover, in order to further enhance transferability, it is recommended that any LD tool can be integrated with any LMS, in such a way that applicability in a wide range of educational settings becomes possible.

Conclusions

In this article, the authors have used the evaluation of a specific LD tool as a proof of concept to validate suggestions and hypotheses made in recent years by a number of LD researchers regarding effective ways to support the LD process with digital technology.

In this respect, the authors have provided concrete evidence regarding (1) the way an LD tool can support the three main stages of the design process; (2) the way designs can be represented effectively; and – ultimately – (3) the extent to which digital LD tools should be structured or flexible.

The study, otherwise, presents some limitations. The first one lies in the limited exploration of the Implementation functionality. This led the authors to draw cautious conclusions in the discussion on this phase and to suggest more in-depth studies. As stated above, usability issues in this last phase might affect the adoption intention.

Moreover, one aspect that has not yet been sufficiently studied is the adoption and use of the tool by teachers over time. The data the authors have collected and discussed so far are limited in that they were gathered within isolated training events, with no possibility of getting back to participants to check whether and to what extent their design practice had actually changed in the medium and long term. A long-term study in an ecological setting would be necessary to concretely explore the sustainability of the PP adoption. Even if the tool was perceived as useful and easy to use by the participants in this study, it is evident that constraints posed by the everyday practice might affect teachers' concrete adoption in the long term. In particular, the issues of 'time' and 'teachers' everyday workload' that already emerged during this evaluation study would be worthy of deeper analysis, as they are often mentioned as being among the main barriers contrasting long-term adoption of LD tools, according to a review of the literature (Dagnino et al., 2018).

Moreover, the authors have never had the possibility of studying whether and to what extent such training events have a knock-on effect, i.e. whether participants pass on the acquired knowledge to their colleagues and whether, as a result, there is any diffusion effect of the LD innovation beyond the restricted circle of the teachers participating in the event. The authors believe these are directions of particular significance for the future of Learning Design both as a research field and as a vehicle for educational innovation, and as such the authors intend to explore them in the coming years.

Notes

1. Examples include https://www.learningdesignplan.com/, which implements the ADDIE model.
2. http://sites.itd.cnr.it/PP/index_en.html
3. The complete questionnaire is available in Italian at the following link: http://goo.gl/forms/rmd0v5kYDR

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