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Representing learning designs in a design support tool

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Abstract

Learning Design (LD) research accounts for several design support tools, or LD tools, employing representations for learning designs to facilitate the "teachers as designers" thinking while preparing learning experiences. In contrast to existing studies having followed mainly a specialist/researcher (as opposed to a teacher) perspective, our quest to develop an LD tool follows a Design-Based Research (DBR) approach involving practitioners. Specifically, in this paper, we attempt to give voice to teachers as designers and investigate how they prefer having their learning designs represented by LD tools. Aiming to create a principled account of how to represent learning designs in an LD tool, we first conducted an integrative literature review to formulate a representational framework that drove our research. Subsequently, we addressed the following LD representational dimensions: (i) format, (ii) organisation, (iii) guidance and support, and (iv) contextualisation. We are reporting on a case study conducted with 16 participants in a teacher education context. Although previous research typically reported findings based on a single LD tool's evaluation over a short period, we have opted for eliciting feedback based on a rich LD experience. To this end, we acquainted participants in LD projects with two LD tools (Learning Designer and WebCollage) during an academic semester. Furthermore, we followed a mixed-method explanatory sequential design applied through a survey questionnaire and semi-structured interviews to achieve a more profound consideration of the teachers' preferences for LD representations. Our findings indicate that the teachers strongly endorse an LD tool supporting a visual format and a global organisation in the form of a table that provides a global overview of a learning design while focusing on its specific elements. Teachers seem to prefer an LD tool that balances providing guidance and flexibility, as they opt for (i) a non-restrictive taxonomy for articulating learning objectives, (ii) some form of standardisation for formatting learning units, along with allowing free formation, (iii) a flexible pedagogical framework for modelling the learning activities' pedagogy so that it can be adjusted to particular designers' needs, and (iv) a typology of technologies that can be utilised or not. In addition, they seemed to favour an LD tool supporting high contextualisation, as they prefer to describe contextual details for a learning design's

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units and activities. These findings constitute design principles for our ongoing DBR and may stimulate momentum for researchers developing LD tools.

Keywords Learning Design · Design Support Tool · Learning Design Tool · Learning Design Representation · Teacher education

1 Introduction

The quest for teacher efficacy calls attention to teachers as learning designers (Pozzi et al., 2015; Prieto et al., 2014). In the direction of teaching as a design science, Learning Design (LD) is an emerging strand of educational research (Ghislandi & Raffaghelli, 2015). LD involves the complex decision-making process undertaken by teachers towards preparing high-quality learning experiences and planning pedagogical interventions, typically in a Technology-Enhanced Learning (TEL) context (Persico et al., 2020). Prior research on LD has identified three main research topics addressing this challenge: *methods*, *processes,* and *tools* (Pozzi et al., 2015). However, they all share a common expected outcome. They aim to support teachers in generating a learning design, i.e., an artefact that records teachers' ideas and represents their intentions for a learning session or even a complete course (Agostinho, 2011; Conole & Wills, 2013).

LD Methods entail structuring a tabular representation of the learning activities and the resources required during a learning session to facilitate teachers' thinking in developing a learning design (Masterman & Craft, 2013). *LD Processes* involve stages formulating the design workflow from inception to enactment (Conole, 2014; Hernández-Leo et al., 2014). *LD support tools*, or simply *LD tools*, can be considered microworlds in which teachers author learning designs (Laurillard et al., 2013). These microworlds employ representations manipulating elements such as a learning design's topic, number of students, intended learning outcomes, learning activities, and the resources required for the activities (Masterman & Craft, 2013).

Focusing on LD tools, we note that they have attracted the interest of researchers as a means to support teachers in representing their teaching ideas; consequently, a variety of computer-based systems have been developed (Bennett et al., 2017; Celik & Magoulas, 2016; Dimitriadis & Goodyear, 2013; Masterman & Craft, 2013; Prieto et al., 2014). Researchers claimed that LD tools provided maieutic support for the design process by allowing the teachers to externalise, reflect on and assess their ideas (Pozzi et al., 2015). Apart from providing a notation system enabling teachers to document their design ideas in a coherent structure (Li et al., 2022), they also facilitate the sharing and reuse of designs (Conole & Wills, 2013; Persico & Pozzi, 2015). Consequently, teachers shift from handwritten notes or simple outline sheets to digital LD representations towards a new perspective to their quest for more pedagogically sound and effective LD practice.

State-of-the-art LD research deems LD tools' potential for supporting teachers' practices as one of the central concerns of the field (Mor et al., 2015). Notably, such research should have followed a user-centred design approach giving voice to the

teachers since the better we understand teachers' current practices and needs, the more effectively LD tools will support them (Bennett et al., 2017; Kali et al., 2011; Pozzi et al., 2020). However, studies on LD tools have mostly taken on a specialist/researcher (as opposed to a teacher) perspective (Prieto et al., 2014). Previous research has paid significantly more attention to developing tools than establishing what teachers need (Kali et al., 2011). Furthermore, existing research seems to have overlooked two factors influencing teachers' perspectives on LD tools. The first factor refers to teachers as designers' practices reflecting the affordances offered by LD tools (Stefaniak et al., 2021). LD research typically included evaluation studies about individual LD tools (for example, see: Katsamani & Ret al.,is, 2013; Papanikolaou et al., 2016; Pozzi et al., 2020; Villasclaras-Fernández et al., 2013; Zalavra & Papanikolaou, 2019). However, utilising a single tool inevitably limits teachers' LD experience to the affordances of only one tool (Prieto et al., 2014). The second factor refers to studies reporting teachers' limited perspectives in the context of short training sessions and workshops lasting between a few hours to a couple of days (for example, see: Albó & Hernández-Leo, 2018; Masterman & Craft, 2013; Pozzi et al., 2020; Prieto et al., 2014).

Addressing this research gap, in our quest to develop an LD tool that will best meet the needs of teacher designers, we considered Design-Based Research's (DBR) potential for educational research (Anderson & Shattuck, 2012). As the DBR approach builds synergistic relationships with practitioners (Plomp, 2013), our research follows a user-centred perspective on LD tools involving practitioners. Furthermore, we opt to conduct rich case studies with small convenience samples as an appropriate design context for collecting in-depth practitioner feedback (Yin, 2018). As part of our ongoing DBR, in this paper, we report on one of the case studies realised in the first DBR phase aiming to conduct a user-centred needs and context analysis.

Specifically, this paper is organised around the research question "*How to represent learning designs in a design support tool?*" and investigates LD representation by considering research literature and teachers' preferences. The literature review section describes our integrative literature review (Torraco, 2005). In this review, we identified LD representational dimensions and formulated a framework that has driven our research. From this framework, in this study, we considered the following LD representational dimensions: (i) format, (ii) organisation, (iii) guidance and support, and (iv) contextualisation. In the methodology section, we outline a case study conducted with 16 participants in the context of a postgraduate programme in teacher education. This context allowed us to involve participants in LD projects realised in two LD tools during an academic semester, thus enriching their perspective in and experience of utilising them. In this way, we managed to collect feedback from practitioners based on a rich LD experience. Furthermore, leveraging the integrative approach of mixed research methods as a means of maximising the credibility of the ongoing DBR research (Wang & Hannafin, 2005), we followed a mixed-method explanatory sequential design (Creswell & Plano Clark, 2017). In the findings section, we report on the participants' responses to a survey questionnaire and their feedback in semi-structured interviews towards a more profound insight in the teachers' perspectives. Finally, we interpret the findings in the discussion

section to infer the teachers' preferences for LD representations. These preferences constitute design principles to be further tested by our research team in the second DBR phase. These design principles might also stimulate momentum for researchers developing LD tools.

2 Literature review

The trend towards computer-supported LD resulted in various LD representations actualised in LD tools (Pozzi et al., 2015). This diversity necessitated identifying LD representational dimensions and formulating a framework to drive our research. We chose to conduct an integrative literature review as it is a straightforward form of research that reviews, critiques, and synthesises representative literature on a topic in an integrated way so that new frameworks and perspectives on the topic are generated (Torraco, 2005). We started in the Scopus database using the search term "learning design representation" within the paper title, abstract and keywords. As this search produced only 11 results, we then applied a snowballing process whereby we reviewed papers sourced to find other relevant papers for inclusion in the sample. To approach the state-of-the-art LD research, we considered papers published in the past decade and formed an initial set of 57 potential sources referring to LD representation. We reviewed these papers in more detail to determine how they address LD representation and classified them into five categories:

i. 5 papers focused on LD tools' representational dimensions providing a systematic analysis;
ii. 12 papers overviewed some LD tools without systematically analysing their representational dimensions, mainly at a background level;
iii. 15 papers just mentioned LD representation as a critical issue in LD research, mainly at an introductory level;
iv. 21 papers conceptualised and/or presented and/or evaluated a specific tool without systematically analysing its representational dimensions;
v. 4 papers focused on the dimension of representational format investigating a particular type.

Since our aim was to make a principled account of how to represent learning designs in an LD tool, it seemed reasonable to focus on papers that systematically analysed representational dimensions. In what follows, we provide an overview of the first five papers. We selected these papers as they adopted a systematic approach and provided novel findings to the LD research regarding representational dimensions. Also, we noted their high citation frequency by the rest of the papers included in our sample.

Agostinho (2011) studied LD representations and mentioned: (1) E2ML, (2) IMS LD, (3) LAMS, (4) LDVS, (5) LDLite and (6) Patterns, noting their threefold *purpose*. The first purpose involved offering human interpretation through textual descriptions and visual diagrams, while the second one entailed technical

interoperability and formation in a computer-interpretable language. Alternatively, the third purpose was to serve both aforementioned purposes aiming to facilitate teachers design and run learning activities.

Besides, in a study on LDVS, the researcher reported that designers appreciated its visual *format,* sequential *organisation,* simple *formalism* in describing teaching practice and adaptable *guidance* to suit teachers' needs.

Conole (2013) classified LD representations based on three aspects. The first aspect was the *format* ranging from text-based to visual. The second aspect was the *level* of the learning experience spanning from small-scale to the whole curriculum. The last aspect was the designers' *lens* of the representation. The researcher explained the term "lens", mentioning that the designers' focal point may involve formulating a design's resources or articulating overarching pedagogical principles.

Conole and Wills (2013) identified seven key facets of representing learning designs:

- Provide some form of *guidance and support* towards shifting teachers' focus from content to activities and the learner experience;
- Exploit the power of visualisation to *format* representing designs towards guiding the design process and thinking about different design aspects;
- Balance the *formalism* of the representation between design representations that are rigorous, precise and perhaps machine-runnable and those which are closer to actual practice and are more creative and somewhat 'fluffy';
- Determine the level of in-context *support and guidance* provided to designers and how such support can be created on the fly from up-to-date and authoritative sources;
- *Support* both LD as a process and its outcome, i.e. LD as a product;
- Support the *organisation* of structured sequences of learning activities and how to represent and share practice;

- Acknowledge the impact of the LD tools' inherent affordances on how the practitioner actualises the design process to address the designers' *lens* to designing for learning.

Masterman and Craft (2013) asserted that the representation of a learning design and its associated notation should be theory-oriented. They suggested that the framework of epistemic efficacy provides five dimensions on how LD representations are involved in the design process:

- fit the design elements interwoven into the learning *context*;
- the *purpose* of the task that the representation is intended to facilitate;
- how best to *support* the cognitive processes of a designer utilising representations;
- *guide* designers according to their differing needs and preferences; and
- the environment's *format* in which the representations are constructed and manipulated.

Also, these researchers' approach to authoring a learning design focused on matching these dimensions either to teachers' needs or to the requirements arising from the learning context.

Pozzi et al. (2016) noted two types of LD representational *format*. The first type involved textual representations that may be expressed freely in a natural language, through narratives, without constraints and imposed structure. Alternatively, they might take the form of formal descriptions expressed in a computer-interpretable language. The second one consisted of visual representations that relied on a diagrammatic or graphical format. Visual representations aim to convey an overall view of the design or specific elements, such as the intervention structure, the learning objectives, the contents to be addressed, etc.

Pozzi et al. (2016) also indicated that the level of *formalism* could characterise learning design representations. Designs can be highly formalised by applying fixed syntactic and semantic "rules". Alternatively, they can be less formalised by not imposing such rules and granting the designers freedom of expression while leaving ample space for ambiguities. In the same line, the *contextualisation* level may be considered. On the one hand, representations may provide an outline and result in an abstract design. On the other hand, representations may enable specifying contextual details (e.g. encompassing information about the design's enactment). Finally, the researchers indicated the *purpose* of the representation as a representational dimension. They noted that some representations aim at the actual design process. Others aim to share designs and communicate design ideas, while others purport to support the automatic configuration of ready-to-use learning environments.

Considering the terminology, the definitions, and the examples used in these papers allowed us to extract the representational dimensions of *purpose*, *format, level, lens, guidance and support, organisation, formalism* and *contextualisation.* We aggregated these eight dimensions into the following LD representational framework considering their types and LD tools' features implementing them:

1) The *purpose* (Agostinho, 2011; Masterman & Craft, 2013; Pozzi et al., 2016) refers to features facilitating learning intervention design or deployment or both.
2) The *format* (Agostinho, 2011; Conole, 2013; Conole & Wills, 2013; Masterman & Craft, 2013; Pozzi et al., 2016) involves features that either support text-based or visual representation or a combination of them.
3) The *level* (Conole, 2013) refers to features supporting interventions spanning from small-scale to the whole curriculum.
4) The *lens* (Conole, 2013; Conole & Wills, 2013) involves features that focus on specific learning design elements, e.g. elements elaborating a design's pedagogy.
5) The *guidance and support dimension* ((Agostinho, 2011; Conole, 2013; Conole & Wills, 2013; Masterman & Craft, 2013) refers to the degree of support provided to designers in terms of structuring, articulating and modelling specific learning design elements, such as the content, the technologies and/or the pedagogy.
6) The *organisation* ((Agostinho, 2011; Conole & Wills, 2013) refers to features composing the organisation of learning activities' sequences and providing either a global overview or some sequential form of the design or a combination.

7) The *formalism* (Agostinho, 2011; Conole & Wills, 2013; Pozzi et al., 2016) involves features supporting rigorous, precise and perhaps machine-runnable representations, thus supporting a high level of formalism. Alternatively, features may grant the designers freedom of expression, thus being less formalised.
8) The *contextualisation* (Masterman & Craft, 2013; Pozzi et al., 2016) refers to the level that LD features support articulating a design's context, spanning from composing an abstract design to a highly structured one that enables specifying details of a design's elements.

This LD representational framework has driven our research described in the following sections.

3 Methodology

3.1 Context and participants

We report on a case study conducted in our quest to develop an LD tool following a DBR. We organised this case study in teacher education, specifically in the context of the two modules "Digital Technologies in Distance Learning" and "Collaborative Learning with Digital Technologies and Social Networks in education", offered in a trans-institutional postgraduate programme on digital transformation and educational practice, organised by 3 Greek universities.

Aiming to conduct a user-centred needs and context analysis during the first phase of this DBR, we applied a convenience sampling strategy by involving all the attendees of the modules in the case study. Although both modules were taken by 19 attendees, we had to exclude data from 3 attendees who did not consent to be part of the study. Table 1 includes the participants' demographic characteristics to determine our sample's diversity.

The participants attended in parallel the two modules within a semester. In the context of these modules, they were organised in teams of up to three members and were involved in two LD projects.

The 1st module of "Digital Technologies in Distance Learning" entailed carrying out an LD project in 4 phases in which teams (1) authored a learning design in Learning Designer (Laurillard et al., 2013), (2) participated in a peer evaluation activity to give/get feedback, (3) redesigned their design and, (4) developed a course in Moodle based on their design. The learning designs had to meet the following: (i) integrate technological resources with web-based tools, (ii) follow specific principles (given by instructors) for developing distance learning content and (iii) support personalised learning.

The 2nd module of "Collaborative Learning with Digital Technologies and Social Networks in education" spanned its LD project into 4 phases in which teams (1) authored a learning design in WebCollage (Villasclaras-Fernández et al., 2013), (2) practised microteaching within each team "teaching" their peers who played the role of the students, (3) participated in a peer evaluation activity to give/get feedback on the microteaching sessions, and (4) reflected on their practice by considering their

Table 1 The participants' demographic characteristics (n = 16)

Characteristic	Convenience sample (n = 16)
Sex	2 (12,5%) Male 14 (87,5%) Female
Age (years)	4 (25%) 20–25 years old 5 (31,3%) 25–30 years old 4 (25%) 30–35 years old 3 (18,7%) 35–40 years old
Teaching Experience	12 (75%) In-Service 4 (25%) Pre-Service
Level of Expertise in LD	3 (18,7%) Low 6 (37,5%) Moderate 7 (43,8%) High
Prior experience in LD tools	16 (100%) None
Academic Disciplines	2 (12,5%) Pre-primary education 4 (25%) Primary Education 3 (18,7%) Computer Science 1 (6,3%) Mathematics 1 (6,3%) Engineering 3 (18,7%) Greek language & Literature 1 (6,3%) English Language 1 (6,3%) Sociology

peers and the teacher's feedback. The learning designs had to meet the following: (i) apply a collaborative learning technique such as Brainstorming or Jigsaw, and (ii) integrate technology with Web 2.0 tools to implement the collaborative technique.

3.2 Materials

In this study, we utilised Learning Designer (Laurillard et al., 2013) and WebCollage (Villasclaras-Fernández et al., 2013), available at https://www.ucl.ac.uk/learning-designer/ and https://ilde2.upf.edu/gr/ respectively. We based our choice on their open-access availability, straightforward and malleable design support, and complementary features according to the LD representational dimensions described earlier in the Literature Review section.

The Learning Designer is a graphics-based tool employing the Conversational Framework (Laurillard, 2012). Its design representation incorporates a representation allowing designers to author a design's topic, time, aims, outcomes and Teaching–Learning Activities (TLAs). Figure 1 depicts a representation of authoring a learning design during the study. Regarding the LD representational dimensions investigated, the Learning Designer supports the following types:

(i) Visual *format*. It provides a tabular representation of the overall learning design.
(ii) Global *organisation*. It allows previewing the overall learning design and scrolling within the learning activity flow.

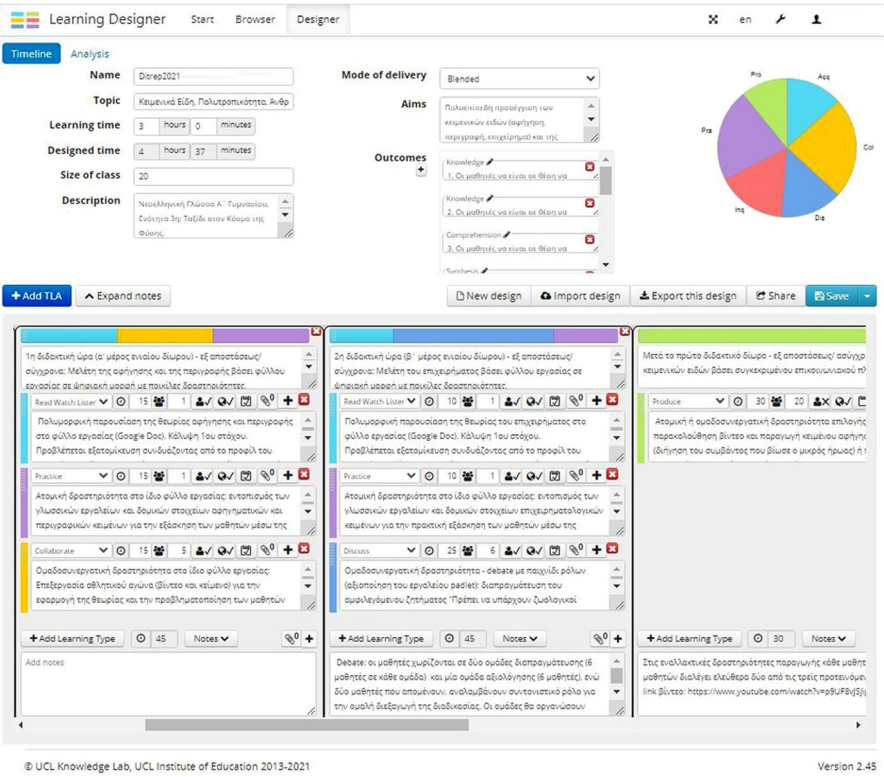


Fig. 1 The representation supported by Learning Designer for authoring a learning design during the study

(iii) High degree of *guidance and support*. It scaffolds the definition of the learning objectives based on the revised Bloom's taxonomy (Anderson & Krathwohl, 2001). Also, it supports characterising activities' types based on the Conversational Framework to overview the learners' experience. It allows elaborating on the resources and tools incorporated in the activities.

(iv) High level of *contextualisation*. It enables specifying the delivery mode of the overall learning design and selecting specific information (duration, number of students, teacher availability, delivery mode) about the context of each learning activity.

The WebCollage is also a graphics-based tool developed to aid teachers as designers in organising collaborative learning activities. It incorporates three representations for authoring a learning design: (i) articulation of the design's course information, including the topic, the prerequisites and the learning objectives, (ii) definition of the resources and technologies used and (iii) formation of the learning activity flow in units. Figure 2 depicts these three views of a learning design

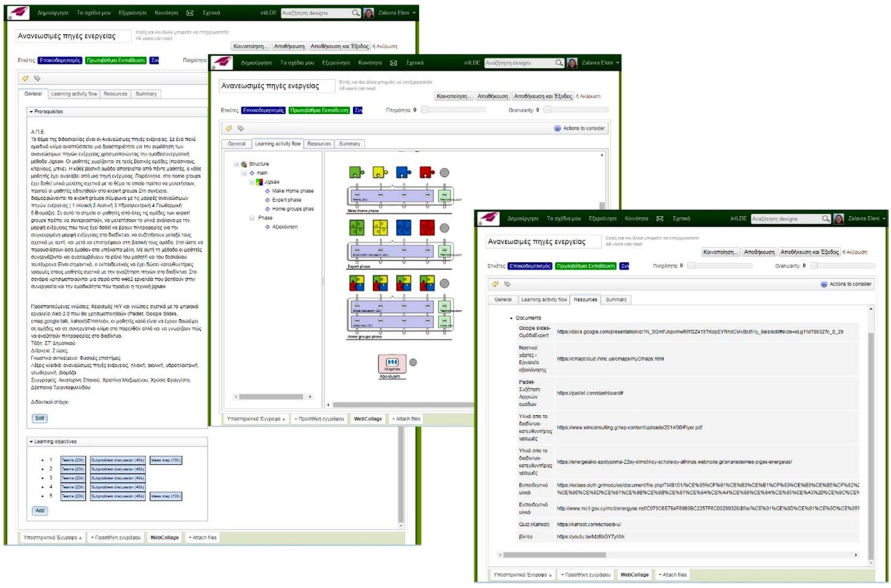


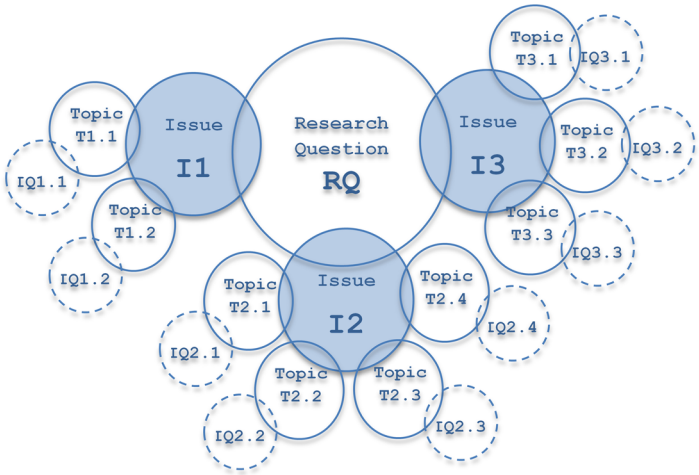
Fig. 2 The representation supported by WebCollage for authoring a learning design during the study

developed during the study. Regarding the LD representational dimensions investigated, WebCollage supports the following types:

(i) Mixed *format*. It supports a graphical representation of the learning activity flow and textual for the design's course information.
(ii) Semi-Global *organisation*. It allows viewing the overall learning activity flow and focusing on specific activities. Separate views include the course information, learning objectives and resources and tools.
(iii) Medium degree of *guidance and support*. It aims to be pedagogically neutral and focuses only on guiding designers to structure learning units by applying collaborative learning techniques or allowing them to structure the units of their design freely. It enables declaring the learning objectives and the resources and tools incorporated in the activities.
(iv) Low level of *contextualisation*. It enables specifying basic information about design elements while allowing the designer to articulate context details freely.

3.3 Research design

An important study design decision that subsequently affected data collection and analysis was to follow an anticipatory data condensation process (Jorrín-Abellán et al., 2021; Miles et al., 2014). As seen in Fig. 3, we identified three main issues and defined relevant topics pertaining to each issue and informative questions to explore them (Jorrín-Abellán et al., 2021; Stake, 2010).



I1 *What LD representational format and organisation do teachers prefer as designers?*
- T1.1 Format of the representation
- IQ1.1 Do teachers prefer text-based, visual or a combination for LD representational format?
- T1.2 Organisation of the representation
- IQ1.2 Do teachers prefer serial sequence, global overview or a combination for LD organisation?

I2 *What degree of guidance and support in LD do teachers prefer as designers?*
- T2.1 Articulation of learning objectives
- IQ2.1 Do teachers prefer free or structured (based on a taxonomy) articulation of a design's learning objectives?
- T2.2 Formation of learning units
- IQ2.2 Do teachers prefer free or structured (based on didactic techniques) formation of a design's learning units?
- T2.3 Modelling of learning activities pedagogy
- IQ2.3 Do teachers prefer free or structured (based on a pedagogical framework) modelling of a design's learning activities pedagogy?
- T2.4 Description of the integration of resources and technologies
- IQ2.4 Do teachers prefer a free or structured (based on a taxonomy) description of a design's resources and technologies?

I3 *What level of contextualisation in LD do teachers prefer as designers?*
- T3.1 Description of course context
- IQ3.1 Do teachers prefer providing an outline or specifying contextual details for a design's course context?
- T3.2 Description of learning units context
- IQ3.2 Do teachers prefer providing an outline or specifying contextual details for a learning design's units context?
- T3.3 Description of learning activities context
- IQ3.3 Do teachers prefer providing an outline or specifying contextual details for a learning design's activities context?

Fig. 3 Anticipatory data condensation diagram showing research question (RQ), issues (I), topics (T) and informative questions (IQ)

The three issues were derived from the LD representational framework described in the previous section. They address the representational dimensions of (i) *format*, (ii) *organisation*, (iii) *guidance and support*, and (iv) *contextualisation*. We didn't address the dimension of the *purpose* of the representation since we focused on authoring a learning design without the burden of meeting specifications for enactment in a specific digital learning environment. We did not consider the *level* of the

representation as we focused on designing courses, i.e. the micro-level of designing for learning rather than designing for meso and macro interventions (Conole & Jones, 2010). Likewise, we didn't address the *lens* of the representation as we didn't intend to focus on a specific element. Finally, we didn't address *formalism* as we had already chosen a high level of formalism. We considered that literature had reported a low level of formalism entailing a "fluffy" approach (Conole & Wills, 2013) and ambiguities (Pozzi et al., 2016) in the design representation. Also, a low level of formalism may be appropriate for brainstorming when conceptualising a learning design (Pozzi et al., 2016). Since our focus was on authoring a learning design, we opted for a high level of formalism, considering an explicit approach to be a prerequisite of LD representation.

3.4 Procedure

Applying a mixed-methods sequential explanatory research design (Creswell & Plano Clark, 2017), at the end of the semester, after the participants concluded their LD projects, we collected quantitative and qualitative data about their LD experience. Specifically, utilising the convenience sample of 16 participants, we collected and analysed their preferences through a survey questionnaire. Then, opting for a maximum variation sample, we selected 8 participants for interviews so as to achieve a deeper understanding of these preferences. We intended that the quantitative data and the corresponding analysis provide a general view of the trends that may answer the research question "*How to represent learning designs in a design support tool?*". The qualitative data that followed and its analysis aimed to clarify and explain those statistical results by exploring the participants' views regarding LD representations in more depth. Thus, although the small sample does not allow us to generalise, through this methodological approach, we expected to increase our understanding and both the credibility and transferability of the study findings.

The instrument used for quantitative data collection was a survey questionnaire. This survey questionnaire included nine questions in line with the nine informative questions (see IQ1.1, IQ1.2, IQ2.1, IQ2.2, IQ2.3, IQ2.4, IQ3.1, IQ3.2 and IQ3.3 in Fig. 3). We formed them as five-scaled semantic differential questions (Osgood, 1952). This scale was deemed adequate for acquiring information on where the participants' preferences lie along a continuum between the two contrasting types investigated (narrative-visual, serial-global, free-structured) for each representational dimension. These contrasting types served as bipolar pairs.

It is worth mentioning that this questionnaire was piloted in its early stages to test the participants' understanding of each question. The need to facilitate the participants by providing them with examples of representational dimensions emerged during this piloting. Subsequently, we complemented each question with screenshots depicting the two tools' contrasting representational types. The screenshots included the representations of the two LD tools utilised during the study and marked them on the five-scale. For example, see the first question in Fig. 4. We expressed it as "*How do you prefer having the representation of a learning design formatted*? (1: Narrative– 5: Visual)" in line with the informative

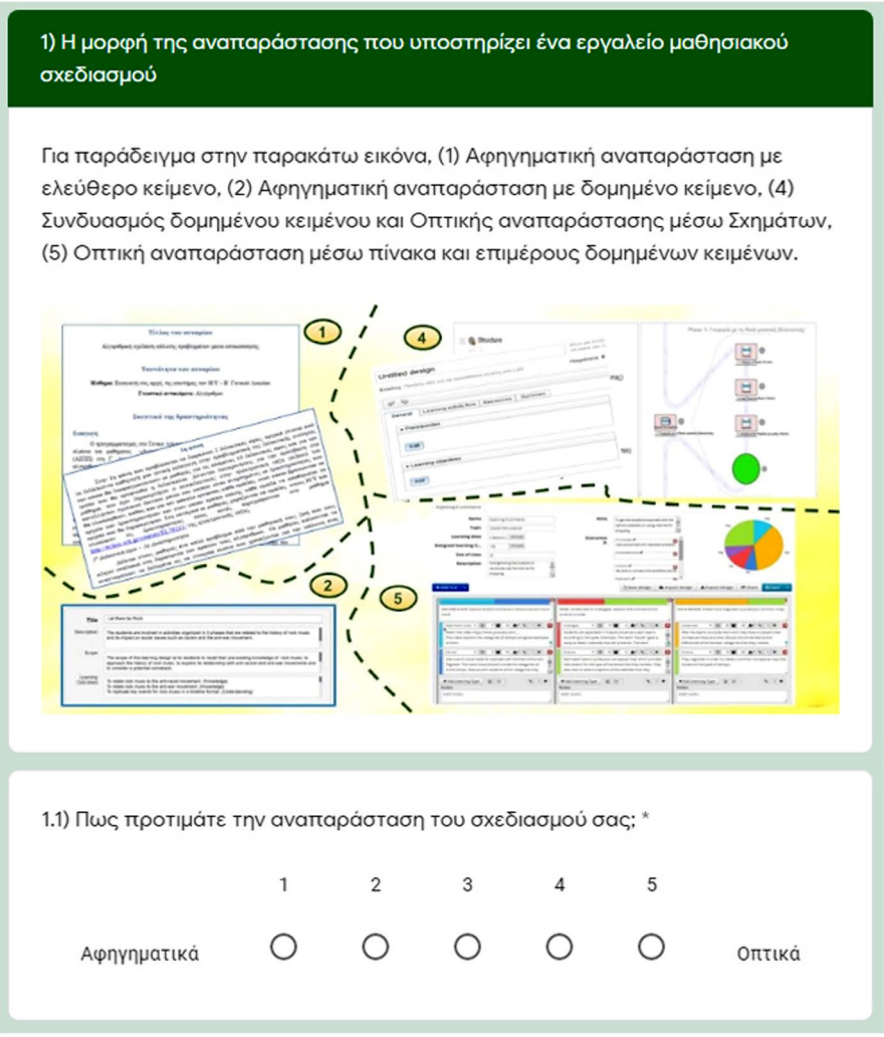


Fig. 4 The presentation of the question "How do you prefer having the representation of a learning design formatted? (1:Narrative– 5:Visual)" in the survey questionnaire

question IQ1.1 "*Do teachers prefer text-based, visual, or a combination of representational formats?*". We complemented it with four screenshots. Notice that we marked the Learning designer's representational format as "5: Visual". And we marked a text-based articulation in a word processor as "1: Narrative".

We performed the quantitative data analysis on SPSS v26 of the participants' responses. We determined Cronbach's alpha to be 0.62, indicating moderate but acceptable internal consistency (Hulin et al., 2001). The findings section presents the descriptive statistics per informative question in Tables 2, 5 and 8.

Table 2 Participants' responses addressing IQ1.1 and IQ1.2 in the survey questionnaire (n = 16)

Topic	1 (Narrative)	2	3	4	5 (Visual)	Mean	SD
T1.1 The representational format	0 (0%)	0 (0%)	1 (6,3%)	4 (25%)	11 (68,8%)	4,63	0,619
	1 (Serial)	2	3	4	5 (Global)		
T1.2 The representational organisation	0 (0%)	0 (0%)	1 (6,3%)	2 (12,5%)	13 (81,3%)	4,75	0,577

The instrument used for qualitative data collection was semi-structured interviews. Instead of involving all the participants, we chose half of them using the popular maximum variation sampling strategy. Our rationale was to choose diverse participants who were expected to hold different perspectives (Creswell & Plano Clark, 2017). The criteria for maximising differences were the participants' demographic characteristics focusing on gender, teaching experience and academic discipline. Specifically, the participants' synthesis included 2 (25%) male and 6 (75%) female. In-service and pre-service teachers participated equally. And, their academic disciplines were 1 (12,5%) Pre-primary education, 2 (25%) Primary Education, 1 (12,5%) Computer Science, 1 (12,5%) Mathematics, 2 (25%) Greek language & Literature and 1 (12,5%) Sociology.

The survey questions were also used as a coarse-grained script for the semi-structured interviews. In the 30-min interviews, we asked participants to elaborate on their answers to the survey questions. In this way, we collected qualitative data providing a more profound insight into the preferences expressed in the quantitative instrument, aiming to clarify and explain the participants' perspectives.

We analysed the participants' answers to each question of the interviews following a deductive coding process as we were interested in gaining insights into three themes: (1) preferred types of representational dimensions and justifying arguments, (2) LD tools' features implementing the preferred types of representational dimensions, and (3) additional features required for implementing the preferred types of representational dimensions. Content analysis around these themes was performed in NVivo by one of the researchers, who systematically consulted the other researchers. The coding procedure around the first theme was identifying the participants' arguments for their preferable type. Subsequently, the classification of the arguments produced codes. For example, the content analysis for the dimension of LD representational format involved spotting arguments for visual representation as no one argued in favour of the text-based format. Then, classifying the arguments generated three codes (convenience, ease, and effectiveness), providing insights into participants' preference for a visual representation. Last, we performed a frequency analysis of the content analysis results, i.e., of the codes found per theme (Neuendorf, 2020) and presented it per informative question in the findings section.

4 Findings

We report on the study findings referring to the Issues (I), Topics (T) and Informative Questions (I.Q) set in the study's research design. Also, we structure them around the themes investigated.

4.1 The LD representational format and organisation (I1)

4.1.1 Theme 1: Preferred types of representational format and organisation and justifying arguments

According to the descriptive statistics of the responses to the survey questionnaire shown in Table 2, there is an indication of a strong tendency toward a visual format (M = 4,63) and global organisation (M = 4,75). Considering frequencies, it is worth mentioning that no participants opted for a narrative (text-based) format or a serial organisation.

The content analysis of the corresponding interview data provides insights into these responses.

The arguments' codes supporting the types of visual format and global organisation are included in Table 3, along with indicative quotes.

4.1.2 Theme 2: LD tools' features implementing the preferred types of representational format and organisation

Regarding the application of visual format and global organisation, the content analysis of the interviews indicated that the vast majority (87,5%) prefered visual formatting as a table that fits in a single window and provides a global overview of the design. The participants explicitly stated their preference for the Learning Designer, as the following quotations show:

> "I liked the visualisation that the Learning Designer had in the form of a table. WebCollage also provided a visual format for the activities flow, but I did not like its graphs." (P8)
> "I liked the organisation of the Learning Designer because, in just one window, you have everything. You have an overview of the topic, the outcomes, the activities." (P1)

4.1.3 Theme 3: Additional features required for implementing the preferred types of representational format and organisation

Additional features required by the participants who stated that they were missing from the environment of Learning Designer are presented in Table 4.

Table 3 Arguments regarding types of representational format and organisation (n = 8)

Topic	Type	Code	Frequency	Indicative Quotes
T1.1 The representational format	Visual Format	Convenience	5 (62,5%)	"As a visual learner, I comprehend things by sight. Narratives do not suit me at all." (P3)
		Ease	4 (50%)	"…helps to identify a design's elements easily and quickly." (P6)
		Effectiveness	5 (62,5%)	"…is more straightforward as it allows overviewing the basic structure of a learning design." (P4)
T1.2 The representational organisation	Global Organisation	Convenience	5 (62,5%)	"I want to be able to see all the information." (P7)
		Ease	2 (25%)	"…makes it easier to edit the various elements of a learning design without having to navigate forward and backwards." (P3)
		Effectiveness	3 (37,5%)	"…allows supervising all the learning design and promotes completing, correcting, and improving it." (P5)

Table 4 Additional features needed for visual format and global organisation (n = 8)

Topic	Feature	Frequency	Indicative Quotes
T1.1 The representational format	Highlight	1 (12,5%)	"I would like to edit the font of the text I am inputting in a design; for example, being able to highlight keywords." (P2)
	Visual Output	2 (25%)	"Visualisation should be applied while editing/viewing a design and also at its output. WebCollage provides such an output, but the Learning Designer produces a narrative which is not helpful." (P4)
	Focus on specific elements	4 (50%)	"I would like to have a window where I can access the whole learning design, to be able to see all its learning units and click to focus on details, to focus on one learning unit and see all its activities. Respectively, by selecting an activity to be able to focus on its details." (P6)
T1.2 The representational organisation	Analysis	2 (25%)	"In WebCollage, I liked a design's learning unit being divided into subunits." (P2)

4.2 The degree of guidance and support in LD (I2)

4.2.1 Theme 1: Preferred Types of guidance and support and justifying arguments

Table 5 shows a low tendency toward a structured articulation of learning objectives (M = 3,25) and a structured formation of learning units (M = 3,38). Also, there was a high tendency towards structured modelling of the learning activities' pedagogy (M = 4,06). Regarding the description of the resources and technologies integrated into a design, the responses seem balanced (M = 2,88). The same proportion of respondents were inclined towards either a free or a structured description.

The content analysis of the participants' interviews addressing the same topics provided the arguments' codes included in Table 6 regarding their preferences.

4.2.2 Theme 2: LD tools' features implementing the preferred types of guidance and support

Regarding the type of guidance and support required while articulating learning objectives, the participants seemed to appreciate the verbs provided in the Learning Designer based on the revised Bloom's taxonomy. For formulating learning units, they deemed the features included in WebCollage as highly straightforward. The participants highly favoured the Learning Designer for employing the Conversational Framework (Laurillard, 2012) to model a design's pedagogy. Finally, they asked for features allowing flexibility in describing the technologies and resources integrated into a learning design. Indicative quotations follow:

> "I liked how the Learning Designer guided the articulation of learning outcomes based on Bloom taxonomy because it provided the appropriate verbs to be used." (P3)
> "WebCollage allowed an uncomplicated formulation of my design's learning units, while in the Learning Designer I had to provide a narrative with many explanations." (P2)
> "I liked that the Learning Designer supported the characterisation of the learning activities based on the Conversational Framework instead of the pedagogically neutral formation supported by WebCollage. I think that it is a double-edged sword, you may want to model your pedagogy freely, but how sure can you be of your pedagogical approach? You may have ideas, but it is better to adapt them according to a framework." (P2)
> "I would like guidance about technologies. If the LD tool suggests technologies based on a typology, it could scaffold me when I lack ideas. However, I would also like to have the freedom to choose without necessarily following the suggestions provided by the tool." (P3)

Table 5 Participants' responses addressing IQ2.1, IQ2.2, IQ2.3 and IQ2.4 in the survey questionnaire (n = 16)

Topic	1 (Free)	2	3	4	5 (Structured)	Mean	SD
T2.1 Articulation of learning objectives	5 (31,3%)	0 (0%)	2 (12,5%)	4 (25,0%)	5 (31,3%)	3,25	1,693
T2.2 Formation of learning units	3 (18,8%)	2 (12,5%)	1 (6,3%)	6 (37,5%)	4 (25,0%)	3,38	1,500
T2.3 Modelling of learning activities pedagogy	0 (0%)	2 (12,5%)	4 (25,0%)	1 (6,3%)	9 (56,3%)	4,06	1,181
T2.4 Description of the integration of resources and technologies	5 (31,3%)	1(6,3%)	4 (25,0%)	3 (18,8%)	3 (18,8%)	2,88	1,544

Table 6 Arguments regarding types of guidance and support in LD (n = 8)

Topic	Type	Code	Frequency	Indicative Quotes
T2.1 Articulation of Learning Objectives	Structured	Effectiveness	4 (50%)	"…allows a designer to formulate a cognitive outcome clearly." (P3)
	Free	Help elsewhere	1 (12,5%)	"Should I need any help, I think I can find it elsewhere. For example, there are objectives set in the curriculum." (P7)
		Expertise	1 (12,5%)	"I feel confident to articulate learning objectives." (P8)
T2.2 Formation of Learning Units	Structured	Effectiveness	3 (37,5%)	"Structured formation of learning units, e.g., collaborative techniques or inquiry, may trigger me to follow them." (P3) "Standardisation of learning units guides me to format them promptly." (P7)
	Free	Non-fitting structure	1 (12,5%)	"As my design ideas may not fit any standardisation, I highly need an LD tool to support the free formation of my learning design's units." (P8)
T2.3 Modelling of Learning Activities Pedagogy	Structured	Effectiveness	6 (75%)	"Following the Conversational Framework scaffolded me to apply effective pedagogy in my designs." "A designer's narration may communicate the pedagogy poorly while a structured form makes it comprehensible."
T2.4 Description of Resources and Technologies	Structured	Scaffolding	3 (37,5%)	"The LD tool suggesting technologies based on a typology may scaffold me when I lack ideas." (P6)
	Free	Pragmatism	3 (37,5%)	"As technologies constantly evolve, any attempt to structure and typify their description is vain." (P3)

4.2.3 Theme 3: Additional features required for implementing the preferred types of guidance and support

The additional features that participants required are included in Table 7.

4.3 The level of contextualisation in LD (I3)

4.3.1 Theme 1: Preferred types of contextualisation and justifying arguments

As seen in Table 8, there was a low tendency toward specifying contextual details of the course context (M = 3,75) and a high tendency toward specifying contextual details of learning units (M = 4,50) and activities context (M = 4,69).

The tendency to specify contextual details revealed a preference for an LD tool supporting a high contextualisation level. When asked about the same topics, the participants in the interviews provided several arguments that justify this preference. Note that the participants' views addressed several topics (see Table 9).

4.3.2 Theme 2: LD tools' features implementing the preferred types of contextualisation

The majority of the participants (75%) seemed to value the contextualisation supported by Learning Designer, as the following quotations show:

> "The Learning Designer's structure for describing the course context helped me a lot. Having fields to fill in the topic, the scope, the delivery mode and the learning outcomes allowed me to express my intentions more precisely." (P4)
> "I would like a similar structure for describing the context of my design's learning units to the structure available in Learning Designer. To have each unit as a table column that incorporates its activities, the total time and some notes." (P5)
> "I liked the standardised fields available in Learning Designer for filling in a learning activity's context. In my opinion, the fields about the learning type of the activity according to the Conversational Framework, the learning time, the students' group size, the teacher's presence, the delivery modality in terms of being online or not and being synchronous or asynchronous, constitute essential information about a design. I liked the structured form of providing contextual information instead of having to narrate. Narration would require having to write a lot of text." (P6)

4.3.3 Theme 3: Additional features required for implementing the preferred types of contextualisation

Although the Learning Designer's contextualisation dominated in the participants' preferences, the additional features needed are worth considering towards incorporating and refining them. (see Table 10).

Table 7 Additional features needed for guiding and supporting LD (n = 8)

Topic	Feature	Frequency	Indicative Quotes
T2.1 Articulation of Learning Objectives	Non-restrictive taxonomy	2 (25%)	"…be allowed to edit the taxonomy, add something, e.g. an objective about skills. Articulation should be structured, but it should not be restrictive so that I can adjust it to my needs." (P2)
	Examples provided	2 (25%)	"…providing examples would be beneficial as I could have direct access instead of looking for guidance elsewhere." (P5)
T2.2 Formation of Learning Units	Easy formation and representation	2 (25%)	"…ease should apply both to guiding the formation of learning units and for representing them." (P2)
T2.3 Modelling of Learning Activities Pedagogy	Activity type supporting free characterisation	3 (37,5%)	"…add an "other" option to the learning activities' types. For example, a reflection activity does not fit any of the five types of the Conversational Framework. Also, regarding the approach that each type of activity contains a form of evaluation, I believe, corresponds only to the formative evaluation." (P1)
	Didactic Technique	1 (12,5%)	"…support didactic techniques as subcategories of the learning activities. For example, when characterising an activity as discussion, there should be subcategories such as guided discussion, group discussion or carousel discussion."
T2.4 Description of Resources and Technologies	Attachment	3 (37,5%)	"…support the attachment of resources" (P7)
	Recommendation	1 (12,5%)	"…support the recommendation of learning designs based on the technologies they use. For example, I wanted to include a roleplay in my design, and I looked at several designs to find some implementing roleplay and note what technology they used." (P8)

Table 8 Participants' responses addressing IQ3.1, IQ3.2 and IQ3.3 in the survey questionnaire (n = 16)

Topic	1 (Outline)	2	3	4	5 (Specify contextual details)	Mean	SD
T3.1 Description of course context	0 (0%)	0 (0%)	5 (31,3%)	10 (62,5%)	1 (6,3%)	3,75	0,577
T3.2 Description of learning units context	1 (6,3%)	0 (0%)	0 (0%)	4 (25,0%)	11 (68,8%)	4,50	1,033
T3.3 Description of learning activities context	0 (0%)	1 (6,3%)	0 (0%)	2 (12,5%)	13 (81,3%)	4,69	0,793

Table 9 Arguments regarding types of contextualisation (n = 8)

Topic	Type	Code	Frequency	Indicative Quotes
T3.1 Description of course context	Specify contextual details	Scaffold design process	4 (50%)	"Fields asking for contextual details support an inexperienced designer in synthesising an appropriate description." (P1)
T3.2 Description of learning units context T3.3 Description of learning activities context		Model design practice	4 (50%)	"High contextualisation promotes modelling design practice and helps designers speak the same language and convey design ideas effectively." (P8)
		Reflect on design practice	2 (25%)	"Providing contextual information allows reviewing a learning design and considering your choices" (P5)
T3.3 Description of learning activities context		Produce a coherent design	3 (37,5%)	"Providing contextual details when describing the learning activities' context allows the teacher to present his reasoning and produce a coherent design explicitly." (P5)

Table 10 Additional features needed for contextualising a learning design (n = 8)

Topic	Feature	Frequency	Indicative Quotes
T3.1 Description of course context	Fields reinforcing the detailed specification	4 (50%)	"…fields for defining the class and the educational level" (P7), "a field for technical infrastructure required." (P3),
T3.2 Description of learning units context	Fields reinforcing the detailed specification	2 (25%)	"…to have a field indicating a learning unit's delivery mode." (P3)
	Produce automated results	2 (25%)	"…calculate a learning unit's duration from the time estimated for its activities." (P2)
T3.3 Description of learning activities context	Fields reinforcing the detailed specification	2 (25%)	"…standardised fields to formulate personalised learning in terms of accommodating learners profile" (P6)
	Connect the course context to the learning activities context	3 (37,5%)	"I would like to include learning outcomes in the context of an activity. In Learning Designer, I missed being able to declare in each activity its intended learning outcomes. I would like a functionality similar to the one of WebCollage that allows you to select the learning outcomes intended in the specific activity among those that you have initially stated." (P2)
	Incorporate resources	2 (25%)	"I would appreciate being able to incorporate my resources into my design. I mean being able to upload and attach files to the activities apart from providing links. I missed this functionality from both tools as the Learning Designer did not support uploading any file and WebCollage supported only pdfs." (P5)

5 Discussion

To address the representation of learning designs in a design support tool, we explored teachers' preferences in the following representational dimensions: (i) *format*, (ii) *organisation*, (iii) *guidance and support,* and (iv) *contextualisation.* For each dimension, we report the preferred types and justifying arguments, the LD tools' features implementing them, and additional features required.

Regarding the representational *format and organisation*, the teachers in this study strongly leaned towards a visual format and a global organisation (see Table 2). The participants underpinned the convenience and ease of these representational types for a designer. Also, they claimed that a visual vs a textual format and a global vs a serial organisation contribute to the effectiveness of the design process (see Table 3). Thus, regarding visual format, these findings confirm and enrich existing literature. Specifically, existing literature reported visualisation aiding designers to (i) clearly articulate LD, (ii) communicate and share ideas, (iii) promote creative design thinking, and (iv) enable reflection (Agostinho, 2011; Conole, 2013; Conole & Wills, 2013).

However, regarding the representational organisation, the findings contradict previous research. Notably, this study's participants highly endorsed global representational organisation after utilising two LD tools supporting a global and a semi-global organisation. In contrast, the participants in the study of Agostinho (2011) valued sequential organisation, having used one tool that supported it. This contradiction highlights the influence of LD tools' affordances on teachers as designers (Stefaniak et al., 2021) and the need to enrich teachers' perspectives with more than one tool (Prieto et al., 2014).

Furthermore, this study sheds light on how an LD tool should apply a visual format and a global organisation. The participants referred to the features of the two LD tools they used, indicating that they preferred visual formatting in the form of a table that fits in a single window providing a global overview of the design. Additional features required for formatting visualisation and global organisation involved means of highlighting, analysing and focusing on design elements (see Table 4).

Regarding the *degree of guidance and support* provided to designers by an LD tool, we noted different tendencies in this study. These tendencies concerned a lower degree of guidance and support allowing designers to freely express their design ideas or a higher degree provided by a structured learning design representation for filling in its elements. Likewise, researchers previously claimed that there was a lack of teachers' apparent inclination toward one side or the other (Prieto et al., 2014). Also, researchers asserted that an LD tool should support designers but not constrain them to go their way (Laurillard et al., 2013). An LD tool should strike a balance by providing sufficient flexibility to support creativity while providing structure and guidance to less experienced designers (Pozzi et al., 2020). However, we note that this study takes a further step in addressing the issue of guidance and support in LD by providing insights into four topics around LD practice: (i) the articulation of learning objectives, (ii) the formation of learning units, (iii) the modelling of learning activities pedagogy and (iv) the description of the integration of resources and technologies in a design.

The participants' preferences for articulating a design's learning objectives showed a low tendency towards guidance (see Table 5) applied through a typology that promotes the effective formulation of a learning objective. However, the participants argued that an expert designer does not need guidance from an LD tool or can find it elsewhere (see Table 6). The participants seemed to appreciate an LD tool scaffolding a theory-based articulation of learning objectives, e.g. the revised Bloom's taxonomy (Anderson & Krathwohl, 2001). However, they asked for a non-restrictive taxonomy adjustable to their needs. Also, they asked for examples of learning objectives' expressions to guide them in adequately defining them (see Table 7).

The participants' preferences for forming learning design units tended slightly towards guidance (see Table 5). They argued for structure as a means of effectively applying standardised learning units. However, the counter-argument about design ideas not fitting any standardisation emerged, justifying the need for an LD tool supporting a free formation of learning units (see Table 6). Furthermore, participants stressed the need for straightforward formation and representation of learning units (see Table 7).

The teachers in this study strongly prefered structured expression in modelling the learning activities pedagogy (see Table 5). They argued, for example, that designing with a particular pedagogical framework like the Conversational Framework (Laurillard, 2012) scaffolded them to apply effective pedagogy. At the same time, they noted that a designer's narration without any standardisation might communicate poorly the pedagogy (see Table 6). They seemed to prefer utilising a pedagogical framework to characterise the type of activities incorporated in a learning design but required the option to add their own activities types. Also, they required modelling their pedagogy by applying didactic techniques as subcategories of activities' types (see Table 7).

The participants' preferences balanced between structured and free descriptions of the technologies and resources integrated into a learning design (see Table 5). On the one hand, they considered a potential scaffolding of technological decisions through a typology of technologies. On the other hand, being pragmatic, they mentioned that such a typology would soon be obsolete as technologies constantly evolve (see Table 6). Therefore, we infer that flexibility could be an ideal arrangement for designers by either supporting a typology or allowing them to decide freely. Also, participants required that an LD tool should support attaching resources and endorsed a recommendation mechanism of learning designs based on required technologies (see Table 7).

Lastly, we point out that LD literature mainly addressed the representational dimension of *contextualisation* considering how an LD tool embraces appropriate design elements and terminology (Laurillard et al., 2013). This paper enriches LD research by scrutinising contextualisation in LD around three design levels (i) the course context, (ii) the learning units context and (iii) the learning activities context. The participants in this study prefered specifying contextual details when describing the investigated topics (see Table 8). They supported the contextual information specification vs a free form specification, arguing that contextulisation (i) scaffolds

the design process, (ii) models and reflects design practice, and (iii) produces a coherent learning design (see Table 9).

Focusing on describing the course context, they endorsed an LD representation providing fields for filling in the topic, the scope, the delivery mode and the learning objectives. They asked for additional fields to describe the class, the educational level, the technical infrastructure required, the personalised learning application and extra design notes. To define a learning unit's context, they endorsed having a table structure to map units in columns and incorporate activities in rows. They also asked for an automated calculation of a learning unit's duration based on the time declared for the activities incorporated.

To describe a design's activities, teachers in this study liked having standardised fields for filling in contextual information instead of narrating it. They endorsed filling in (i) the learning type of the activity according to a pedagogical framework, (ii) the learning time, (iii) the students' group size, (iv) the teacher's presence, (v) the delivery modality in terms of being online or not and being synchronous or asynchronous, and (vi) the description of resources. Furthermore, they would appreciate three extra functionalities. The first one entails enabling a designer to select the learning outcomes achieved in a specific activity among those stated in the course context. Another desired functionality involves matching the course context to the learning units' and activities' context. And the third one involves incorporating resources into a design for uploading and attaching files apart from providing links as in the two LD tools utilised in the study (see Table 10).

6 Conclusions

In this paper, we investigate LD representations, aiming to provide a principled account of how to represent learning designs in an LD tool.

First, we propose an LD representational framework aggregating previous approaches through an integrative literature review. This framework consists of the following LD representational dimensions: *purpose*, *format, level, lens, guidance and support, organisation, formalism* and *contextualisation.* Also, it includes the LD tools' features implementing these dimensions.

Then, we report on the findings of a case study organised in a teacher education context during the ongoing research of our DBR approach to developing an LD tool. The findings address the teachers' preferences for LD *format, guidance and support, organisation* and *contextualisation.* Their relevance lies in three factors considered for their collection. The first factor involves following a user-centred rather than a researcher-only-based approach (Bennett et al., 2017; Kali et al., 2011; Pozzi et al., 2020). The others refer to the limitations of several existing studies collecting teachers' perspectives through a single LD tool (Prieto et al., 2014) and reporting on an involvement over a short period. Instead, we focused on grounding findings on teachers' rich LD experience. In our case, we catered to enrich the teachers' perspectives by using two LD tools with complementary features of the proposed LD representational framework during an academic semester. Although the limitations

of this work refer to the small sample of participants, the integrative mixed-method design allows us to explore preferences illustrated through these tools.

The findings indicate that teachers strongly endorsed an LD tool supporting a visual format and a global organisation in the form of a table that fits in a single window providing a global overview of a learning design while focusing on specific elements. Ideally, an LD tool should support a balance between guidance and flexibility. Specifically, the teachers seemed to prefer:

(i) a non-restrictive taxonomy for articulating theory-based learning objectives,
(ii) some form of standardisation for formatting learning units, along with the option for free formation,
(iii) a flexible pedagogical framework for modelling the learning activities' pedagogy that can be adjusted to particular designers' needs,
(iv) a typology of technologies that can either be utilised or disregarded.

Lastly, a high contextualisation level is preferred through appropriate fields and functionalities supporting contextual details when describing a learning design's course context, learning units and activities.

The implications of this work are twofold. The first implication addresses the proposed LD representational framework described in the literature review section. This LD representational framework guided the research conducted by our team and may be utilised by other researchers developing LD tools. It may also trigger further research based on a systematic literature review regarding representational dimensions and more case studies or even wider survey-based studies to reinforce the evidence and better understand this complex phenomenon. The second implication refers to the case study findings reporting the teachers' preferences for LD representation. These findings constitute the design principles in our team's quest to develop an LD tool through a DBR approach. Furthermore, they might contribute to enriching the state-of-the-art in the LD field as well as to explicitly facilitating the "teachers as designers" thinking.

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Declarations

Research involving human participants and/or animals: All research complied with all relevant federal guidelines and is in accordance with the ethical standards of the institutional (UNIWA) research and ethics committee.

Informed consent The authors obtained informed consent from all the individual participants included in the study.

Research data policy and data availability statements Materials described in the manuscript, including all relevant raw data, will be freely available to any researcher wishing to use them for non-commercial purposes, without breaching participant confidentiality.

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Conflict of interest The authors declare that they have no conflict of interest.

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