Learning Design Tools and Educational Practice: capturing the features of five popular tools

Aglaia P. Psani[1], Georgia J. Kiriakaki[1], Christos D. Kytagias[1], Ioannis (Yannis) P. Psaromiligkos[1], Ioannis M. Salmon[1], Konstantinos S. Kyprianos[2],
[1]Department of Business Administration,
University of West Attica,
250 Thivon & P. Ralli Str., 12241 Egaleo, Athens,
Greece

[2]Department of Archival, Library and Information Studies,
University of West Attica,
Agiou Spyridonos Str., 12243 Egaleo, Athens,
Greece

Received: April 14, 2025. Revised: July 17, 2025. Accepted: August 21, 2025. Published: May 31, 2026.

Abstract - To facilitate teachers convey educational scenarios, the study reviews five learning design tools: Leaarning Designer, eXe Learning, LAMS, EdCrumble, and Cadmos. Previous research emphasizes the importance of learning design in enhancing teaching quality and simplifying the selection of appropriate tools to cater to educators' varying levels of experience, especially new teachers. The primary aim is to assess the ability of these tools to support teachers throughout the three design phases: conceptual, authoring, and implementation/sharing enabling them to effectively capture and represent a two-hour digital literacy scenario. Forty teachers from a Vocational High School participated in the research. They attended workshops where each design tool was used to model an educational scenario aligned with the curriculum. Workshops introduced teachers to each tool, followed by a practical application of representing a predefined scenario. Data were collected through questionnaires, which were analyzed for reliability and trends in satisfaction. Statistical indicators, such as Cronbach's alpha, were used to validate the results. The tools demonstrated varying strengths: Learning Designer excelled in conceptual guidance, while edCrumble offered comprehensive graphical summaries. Graphical representation was strong in LAMS, edCrumble, and Cadmos, whereas Learning Designer and eXe Learning leaned towards verbal descriptions. Key gaps included limited support for metacognitive objectives and resource classification. Implementation in LMS systems and sharing capabilities also varied among the tools. The study concludes that although the tools meaningfully support teachers in learning design, enhancements are necessary to address existing gaps.

Keywords - Learning design tools, educational scenarios, digital literacy, teacher experience, tool evaluation, design phases, conceptual guidance, Vocational Education.

I. Introduction

THE learning design process involves making decisions about the pedagogical approach, planning learning activities and resources, and defining the roles of all stakeholders [1], [2], [3], [4]. An essential asset for teachers is a deep knowledge of learning design, as it enhances the quality of teaching [5] and enables the adoption of innovative practices that meet the requirements of new pedagogical programs [6], [7], [8]. On the one hand, creating high-quality courses requires improving teachers' design skills [9], [10], and on the other hand, teachers prefer to minimize the time spent designing for learning [11]. Therefore, supporting teachers in learning design remains a challenge [12]. It is recommended that they receive guidance in the design field to enhance their competencies and professional development [13].

Researchers are developing appropriate tools and studying various conceptual approaches that support learning design [14], proposing different tools [15], [16], [17], [18] for all process phases [15]. Despite the intense debate in the field of learning design [19], teachers' adoption of learning design

DOI: 10.46300/9109.2026.20.10 Volume 20, 2026

tools remains low [19], [20], [21], [22], [23], [24], [25], [26], due to the confusion caused by the many tools [27] and the risk of representing their design decisions without precision [28], [29].

Learning design tools employ various pedagogical approaches and require different levels of digital competencies, depending on their complexity and the user's experience in learning design [30]. Since there are many tools available but their use remains limited, it is important to evaluate them based on how effectively they can support each phase of the learning design process [19], [31].

Teachers must select the right learning design tool to support their decisions without investing too much time [11]. Therefore, it is essential to empower teachers to adopt learning design tools and depict their learning scenarios, as this enhances the design process [18], [29]. The main challenge of the research is to capture the functions and features of the available learning design tools. The aim is to facilitate educators in choosing the appropriate tool that can accurately represent their teaching scenarios at each phase of the design.

Recognizing the lack of practical guidance for educators in representing learning plans in design tools [3] and influenced by the work of [18], which examines how different learning design (LD) tools capture educational scenarios, this research aims to explore the various approaches offered by five LD tools. By adopting the 'authoring and sharing tools' category proposed in [3], the study excludes non-active tools within this category. Five tools are selected (Learning Designer, eXe Learning, LAMS, edCrumble, and Cadmos) to examine the unique perspectives of each tool, based on teachers' preferences, when documenting and illustrating a learning scenario.

II. Literature Review

A. Related Work

Research on learning design has often focused on evaluating individual learning design tools [31], [32]. However, relying on a single tool can limit teachers' learning design experiences to the features of that particular tool [25].

In their research [33] evaluate the Learning Designer tool and report that it has the potential to share teachers' learning designs and visually represent learning activities. Furthermore, the tool encourages reflection on teachers' pedagogical choices, while the graphical representation of activities and analysis in various dimensions enhances the organization and understanding of learning objectives [34].

Another study evaluating the edCrumble tool reports that it offers innovative features, such as design analytics and community collaboration, which assist teachers in visualizing their design decision-making [35]. Furthermore, the tool facilitates the sharing and adaptation of learning designs by providing a temporal representation [35]. In another study [36], educators and experts evaluated the GLO Maker, Microsoft LCDS, and Course Lab tools to assess their ease of use and user satisfaction. Other studies examine how Learning Design tools can support the different phases of learning design, emphasizing that they should offer enough flexibility to encourage creativity, while at the same time maintaining a clear structure to guide the teacher [31]. Lastly, the ILDE (Integrated Learning Design Environment) platform aims to assist teachers in designing learning activities by offering tools that enable them to create, design, edit, and share learning plans [29].

Integrating digital tools into learning design can assist teachers' professional development [37] as these tools can potentially enhance their design decisions [5]. Numerous learning design tools have been created to help teachers articulate their lessons and clarify their ideas based on their design choices [33]. However, teachers will need appropriate guidance to adopt design tools that support all phases of the learning design process and to ensure that learning design becomes a catalyst for innovation among educators [6]. The key question is how teachers will choose the right tool that bolsters their design efforts without investing excessive time [11].

Unlike previous studies that focus on individual tools or isolated phases of the learning design process, this work introduces and empirically applies an evaluation framework aligned with the entire learning design lifecycle. The resulting consolidated table clearly highlights the strengths of the tools across different phases, thereby providing a reliable and reusable reference framework for both teachers' tool selection and future research studies.

B. Learning Design

Learning design aims to craft educational activities that highlight the "intuitive processes" of educators [21]. It encompasses the content and methods used during a learning process to achieve specific educational objectives for students [33]. Typically, it is organized as a sequence of learning activities that focus on developing particular skills and knowledge [21]. The development of various learning design tools helps teachers to articulate their courses and clarify their ideas based on their design decisions [33]. However, the steps that support learning design follow a life cycle, and researchers have proposed several models to describe this life cycle. This study is based on the design model detailed in the METIS project [30], which simplifies complexity by presenting three design phases: conceptual, authoring/design, and implementation/sharing [7], [29], [38].

In the conceptual phase, teachers evaluate all the characteristics of their intervention's learning environment. They analyze the target characteristics and establish the learning objectives that the intervention aims to achieve [39].

The representation of the educational scenario is realized in the authoring/design phase, supplying the necessary information for the specific teaching intervention. Learning activities are meticulously planned during this phase, and their flow is established [38].

Finally, the design is delivered as a course in the implementation phase [31]. It is determined how it can be

DOI: 10.46300/9109.2026.20.10 Volume 20, 2026

shared with other teachers [39], [40]. The learning design can be completed at this stage, with all the required details developed in a specific teaching context using a specific digital learning platform/LMS) [31], [38]. In this phase, before the course is carried out in class, it is crucial for teachers, after completing their design, to review it and make any necessary changes, thereby redesigning their pedagogy [33], [41]. For instance, if a teacher describes an activity and finds that the initially allocated time is insufficient for completion, they should be able to revise the design. The research team also sought to study teachers' satisfaction regarding how the tools present the percentages of activity types and time taken in their scenario, allowing them to reflect and redesign accordingly.

III. Methods and Materials

A. Educational Scenario

The study refers to a two-hour teaching scenario for first-year high school students aged 15 to 16. The scenario is about "Digital Literacy" in the context of "Communication and Collaboration through Digital Environments" and it was inspired by an exemplary scenario found on AESOP's digital repository: https://aesop.iep.edu.gr/node/7259. The lesson is intended to be taught in the "Computer Science" class and has been adapted to the current study's goals and objectives to accommodate curriculum-approved pedagogical methods. Designed as a structured learning experience [42], the scenario was implemented using five popular learning design tools: Learning Designer, eXe Learning, LAMS, edCrumble, and Cadmos [29], ensuring a comprehensive evaluation of their effectiveness in the instructional design representation.

B. Research Focus and Questions

The research aims to guide teachers in selecting suitable design tools to accurately represent their instructional decisions and assist them throughout all phases of the design process. The study evaluates how five widely used learning design tools support the representation of a learning scenario in alignment with the three-phase design model: conceptual, authoring/design, and implementation/sharing.

The research questions are the following:

• RQ1: How effectively do learning design tools support teachers' decision-making in the conceptual phase?

• RQ2: How effectively do learning design tools enable teachers to make design decisions during the authoring/design phase?

• RQ3: How effectively do learning design tools assist teachers' design decisions during the implementation/sharing phase?

The study provides a comparative analysis of the features and specifics of five learning design tools to help choose the most appropriate one. This enables teachers to select the best tool for their teaching practice without compromising their design decisions.

C. Case Study and Data Collection

The research is a case study conducted at a Model Vocational High School. It employs a descriptive and exploratory analysis of 40 teachers' opinion about how effective the five learning design tools are in supporting all phases of design. The study also examines how these tools contribute to professional development, school unit progress, and the fostering of collaboration among educators.

As part of the methodology, 40 teachers from Model Vocational High Schools participated in an introductory seminar to enhance their understanding of learning design. This was followed by five-hour workshops dedicated to one of the five learning design tools. The teachers were divided into ten groups and each received a copy of the prototyped collaborative scenario. In addition, the pedagogy for the scenario (Fig. 1) and its flow diagram (Fig. 2) were provided to aid comprehension.

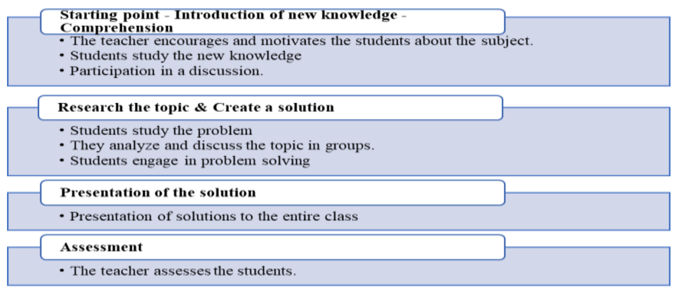

Fig. 1: Teaching scenario
Source: created by the authors

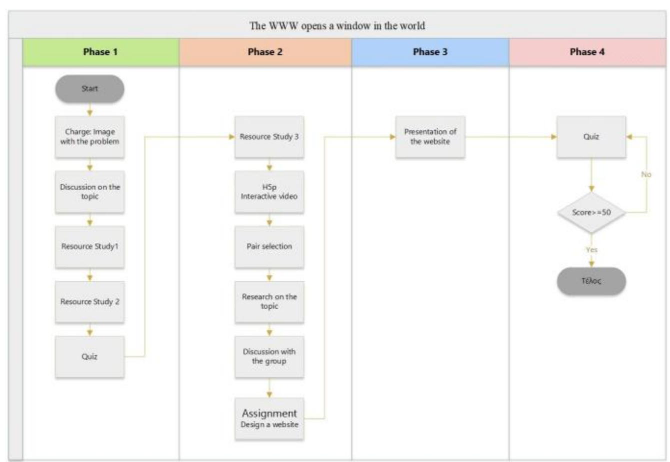

Fig. 2: Scenario's flow diagram
Source: created by the authors

During the workshops, teachers utilized the specific features of each tool to represent the scenario accurately. The research team provided guidance and observed the process. After each workshop, teachers completed an online questionnaire to assess the effectiveness of each tool in supporting the three design phases. The questionnaire was developed based on literature addressing the three-phase model of the design life cycle [30] and the factors influencing each phase [31], [38].

IV. Results

A survey of 38 questions was used to collect the answers comprising of both quantitative and qualitative questions at the conclusion of each workshop. Demographic revealed that 62.5% of the teachers were female and 37.5% were male, indicating an almost even representation of genders among the participants. In the sample 27.5% of teachers were under the age of 35, 37.5% were between the ages of 35 and 45. The teachers represent a wide range of scientific fields, giving a broad understanding of perspectives, but the technical specialties accounted for the majority (70%). 75% of the participants had at minimum two years of teaching experience, suggesting that the study takes into consideration viewpoints of teachers with various experience levels.

A large percentage of the teachers (87.5%) declared familiarity with the concept of learning design, although their expertise in learning design tools varied. Nevertheless, all teachers expressed their desire to learn and adopt multiple tools to support their learning design efforts, indicating its importance and that is timely topic within the educational community (Fig. 3).

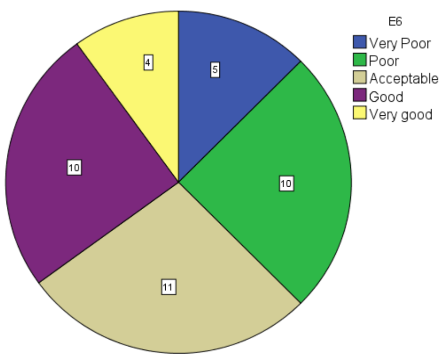

Fig. 3: Teachers' expertise in learning design tools
Source: created by the authors

Initially, Cronbach's alpha was used to evaluate the internal coherence of the subscale factors for each phase [43]. As shown in Table I, Table II, and Table III, all aspects relevant to the three design phases exhibit high internal consistency, indicated by alpha coefficients that exceed the recommended level of 0.70 [44], [45], [46]. Therefore, the scale, as mentioned earlier (See Appendix), that assesses the way in which learning design tools support the representation of a learning scenario according to the three-phase design model - conceptual, authoring/design, and implementation/sharing - is appropriate, with high validity and reliability.

Table I. Reliability Statistics - Conceptual phase

Tool	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Learning Designer	,889	,890	12
eXe Learning	,744	,753	12
LAMS	,764	,776	12
ILDE/edCrumble	,792	,827	12
Cadmos	,813	,815	12

Source: created by the authors

Table II. Reliability Statistics - Authoring phase

Tool	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Learning Designer	,764	,768	9
eXe Learning	,884	,886	9
LAMS	,730	,723	9
ILDE/edCrumble	,744	,732	9
Cadmos	,723	,724	9

Source: created by the authors

Table III. Reliability Statistics - Implementation phase

Tool	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Learning Designer	,776	,790	7
eXe Learning	,718	,729	7
LAMS	,769	,774	7
ILDE/edCrumble	,806	,808	7
Cadmos	,846	,850	7

Source: created by the authors

As shown in Table IV and Table V, the findings from the Mann-Whitney U and Kruskal-Wallis tests indicated that teacher characteristics such as gender and teaching experience did not significantly influence perceptions of tool effectiveness ($p > 0.05$).

Table IV. Mann-Whitney U Test by Gender

	Learning Designer	eXe Learning	LAMS	edCrumble	Cadmos
Mann-Whitney U	153,500	178,000	127,500	171,000	179,000
Wilcoxon W	478,500	298,000	452,500	291,000	299,000
Z	-,950	-,265	-1,678	-,461	-,238
Asymp. Sig. (2-tailed)	,342	,791	,093	,645	,812
Exact Sig. [2*(1-tailed Sig.)]	,346	,804	,094	,659	,825

a. Grouping Variable: Gender
Source: created by the authors

Table V. Kruskal-Wallis Test by Age Group

	Learning Designer	eXe Learning	LAMS	edCrumble	Cadmos
Chi-Square	,560	5,100	,996	2,604	1,858
df	3	3	3	3	3
Asymp. Sig.	,906	,165	,802	,457	,602

a. Kruskal-Wallis Test
b. Grouping Variable: Age
Source: created by the authors

Frequency analysis was conducted to identify patterns and trends in the responses collected on the 5-point Likert scale. Table VI (E9a to E9l) illustrates how learning design tools support teachers' design decisions during the conceptual phase, while Table VII offers an overview of the response distribution in this phase.

As shown in Table VII, the frequency analysis reveals that all teachers agree or strongly agree that all five LD tools accurately describe the scenario's application framework (E9_a) and learning objectives (E9_b).

Table VI. Tool support for teachers’ design decisions in the conceptual phase

Source: created by the authors

Tool		E9a	E9b	E9c	E9d	E9e	E9f	E9g	E9h	E9i	E9j	E9k	E9l
Learning Designer	Median	5,00	5,00	5,00	4,00	3,00	5,00	5,00	4,00	5,00	5,00	5,00	5,00
	Mode	5	5	5	4	3	5	5	4	5	5	5	5
	Std.Dev.	,501	,483	,483	,608	,464	,506	,504	,630	,496	,501	,504	,501
eXe Learning	Median	4,00	4,00	2,00	4,00	2,00	4,00	4,00	4,00	2.50	1,50	1,00	4,00
	Mode	4	4	2	4	2	4	4	4	2	1	1	4
	Std.Dev.	,452	,496	,483	,591	,543	,452	,439	,350	,736	,554	,423	,385
LAMS	Median	4,00	4,00	1,00	2,00	4,00	2,00	2,00	4,00	1,00	1,00	1,00	4,00
	Mode	4	4	1	2	4	2	2	4	1	1	1	4
	Std.Dev.	,335	,496	,504	,501	,335	,526	,501	,450	,362	,452	,452	,572
edCrumble	Median	5,00	4,00	3,00	3,00	3,00	5,00	5,00	5,00	5,00	2,00	5,00	5,00
	Mode	5	4	3	3	4	5	5	5	5	2	5	5
	Std.Dev.	,483	,504	,749	,733	,723	,496	,490	,464	,490	,379	,490	,490
Cadmos	Median	5,00	4,00	5,00	5,00	4,00	2,00	4,00	4,50	5,00	2,00	5,00	5,00
	Mode	5	4	5	5	4	2	4	4[a]	5	2	5	5
	Std.Dev.	,385	,474	,464	,496	,439	,417	,423	,506	,504	,483	,504	,504
a. Multiple modes exist. The smallest value is shown													

However, everyone agrees or strongly agrees that the Learning Designer tool effectively guides the formulation of cognitive and metacognitive objectives (E9_c, E9_j). In contrast, none of the other tools assist in formulating metacognitive learning objectives. Furthermore, all teachers concur that the Cadmos tool adequately supports the guidance of cognitive objectives (E9_c). Additionally, there is a strong agreement that the Cadmos (100%) and Learning Designer (92.5%) tools satisfactorily support the representation of the scenario’s roles (E9_d). Everyone agrees or strongly agrees that the LAMS and Cadmos tools offer functions and standards that support learning strategies with pre-built templates (E9_e). However, a significant percentage of participants (40%) maintain a neutral position regarding the ability to perform this function with the edCrumble tool. In comparison, 45% agree that the tool incorporates learning theories and pedagogical strategies. Moreover, the survey indicates that participants agree or strongly agree that the Learning Designer (100%), eXe Learning (72.5%), and edCrumble (100%) tools adequately support the representation of the educational scenarios’ enactment in class or remotely, in the conception phase (E9_f).

In contrast, they disagree or strongly disagree with the LAMS (97.5%) and Cadmos (95%) regarding the tools’ support for this option (E9_f). Except for the LAMS tool, all participants agree or strongly agree with the ability to visualize individual or group activities (E9_h) and represent the teacher's presence or absence in the scenario (E9_g) for all the tools.

Regarding satisfaction with the learning design tools that depict the execution timeline for all scenario activities (E9_i), all participants either agreed or strongly agreed that the Learning Designer, edCrumble, and Cadmos tools effectively support this feature. However, they did not find the LAMS tool to be sufficient. However, 50% disagreed with the eXe Learning tool, and 35% maintained a neutral position on this feature. Finally, all participants agree or strongly agree that tools allow the visualization of the various types of activities (E9_k), except for eXe Learning and LAMS. Overall, the guidance offered by the tools for representing the learning design in the conception phase (E9_l) is satisfactory for all of them.

Table VII. Distribution of responses in the conceptual phase

		E9a	E9b	E9c	E9d	E9e	E9f	E9g	E9h	E9i	E9j	E9k	E9l
Tool		%	%	%	%	%	%	%	%	%	%	%	%
Learning Designer	Strongly disagree	0	0	0	0	0	0	0	0	0	0	0	0
	Disagree	0	0	0	0	0	0	0	0	0	0	0	0
	Neither agree nor disagree	0	0	0	7,5	70,0	0	0	10,0	0	0	0	0
	Agree	42,5	35,0	35,0	55,0	30,0	47,5	45,0	55,0	40,0	42,5	45,0	42,5
	Strongly agree	57,5	65,0	65,0	37,5	0	52,5	55,0	35,0	60,0	57,5	55,0	57,5
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
eXe Learning	Strongly disagree	0	0	35,0	0	30,0	0	0	0	0	50	77,5	0
	Disagree	0	0	65,0	5,0	65,0	0	0	0	50,0	47,5	22,5	0
	Neither agree nor disagree	0	0	0	30,0	5,0	27,5	25,0	10,0	35,0	2,5	0	17,5
	Agree	72,5	60,0	0	65,0	0	72,5	75,0	87,5	15,0	0	0	82,5
	Strongly agree	27,5	40,0	0	0	0	0	0	2,5	0	0	0	0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
LAMS	Strongly disagree	0	0	55,0	0	0	35,0	42,5	0	85,0	72,5	72,5	0
	Disagree	0	0	45,0	57,5	0	62,5	57,5	0	15,0	27,5	27,5	5
	Neither agree nor disagree	0	0	0	42,5	0	2,5	0	7,5	0	0	0	22,5
	Agree	87,5	60,0	0	0	87,5	0	0	80,0	0	0	0	72,5
	Strongly agree	12,5	40,0	0	0	12,5	0	0	12,5	0	0	0	0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
edCrumble	Strongly disagree	0	0	0	0	0	0	0	0	0	12,5	0	0
	Disagree	0	0	25,0	17,5	15,0	0	0	0	0	85,0	0	0
	Neither agree nor disagree	0	0	45,0	42,5	40,0	0	0	0	0	2,5	0	0
	Agree	35,0	55,0	30,0	40,0	45,0	40,0	37,5	30,0	37,5	0	37,5	37,5
	Strongly agree	65,0	45,0	0	0	0	60,0	62,5	70,0	62,5	0	62,5	62,5
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Cadmos	Strongly disagree	0	0	0	0	0	12,5	0	0	0	20,0	0	0
	Disagree	0	0	0	0	0	82,5	0	0	0	75,0	0	0
	Neither agree nor disagree	0	0	0	0	0	5,0	0	0	0	5,0	0	0
	Agree	17,5	67,5	30,0	40,0	75,0	0	77,5	50,0	45,0	0	45,0	45,0
	Strongly agree	82,5	32,5	70,0	60,0	25,0	0	22,5	50,0	55,0	0	55,0	55,0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Source: created by the authors

As shown in Table VIII, participants' responses to question 10 focus on different aspects of the tools they have or would like to have to facilitate the representation of the design during the conceptual phase.

Table IX shows teachers' satisfaction with the tools based on the factors influencing the authoring/design phase. In contrast, Table X presents an overview of the distribution of responses following frequency analysis for questions E11a through E11i.

Table VIII. Given answers to the open-ended question during conceptual phase

LD Tool	**Response Category (responses included more than one category)**	**Frequency**

Learning Designer	The tool suggests specific verbs to formulate the scenario's cognitive and metacognitive learning objectives.	9 (22,5%)
	The tool's design approach requires teachers to use only one pedagogical theory.	9 (22,5%)
	Having separate frameworks for capturing scenarios' metadata is helpful.	2 (5%)
	The tool provides useful statistical analysis capabilities regarding both the duration of learning activities and their types.	8 (20%)
	None	12 (30%)
eXe Learning	Inability to capture the scenario's duration.	6 (15%)
	It does not include functions for integrating standard learning and pedagogical approaches.	7 (17,5%)
	Lack of separate frameworks for capturing scenarios' metadata.	8 (20%)
	Not all types of activities have their duration captured.	4 (10%)
	None	15 (37,5%)
LAMS	Inability to capture the scenario's duration.	9 (22%)
	Lack of separate frameworks for capturing scenarios' metadata.	8 (20%)
	Inability to define scenarios' roles.	10 (25%)
	None	13 (32,5%)
edCrumble	The tool does not suggest specific verbs to formulate the scenario's metacognitive learning objectives.	10 (25%)
	The tool allows the scenario roles to be defined when each activity is being described.	7 (17,5%)
	The tool provides separate phases according to the pedagogical models, but there is no indication or name for each specific phase.	5 (12,5%)
	None	18 (45%)
CADMOS	The activities can be classified based on Bloom's taxonomy, which guides the formulation of the cognitive learning objectives.	9 (22,5%)
	Having separate frameworks for capturing scenarios' metadata is helpful.	2 (5%)
	The tool facilitates the representation of each activity's duration and the scenario's duration.	2 (5%)
	It offers ready-to-use design templates for different learning strategies.	11 (27,5%)
	The tool does not suggest specific verbs to formulate the scenario's metacognitive learning objectives.	4 (10%)
	None	12 (30%)

Source: created by the authors

Table IX. Tool support for teachers' design decisions in the authoring/design phase

Tools		E11a	E11b	E11c	E11d	E11e	E11f	E11g	E11h	E11i
Learning Designer	Median	5,00	2.50	4,00	1,00	3,00	4,00	4,00	5,00	3,00
	Mode	5	2	4	1	3 [a]	4	4	5	3
	Std. Dev.	,474	,712	,526	,474	,716	,554	,450	,506	,580
eXe Learning	Median	4,00	4,00	4,00	4,00	4,00	4,00	4,00	4,00	3,00
	Mode	4	4	4	4	4	4	4	4	3
	Std. Dev.	,506	,599	,453	,496	,694	,404	,580	,656	,747
LAMS	Median	4,00	4,00	5,00	5,00	4,00	4,00	4,00	4,00	5,00
	Mode	4	4 [a]	5	5	4	4	4	4	5
	Std. Dev.	,506	,594	,464	,506	,453	,389	,555	,496	,526
edCrumble	Median	5,00	5,00	4,00	4,00	5,00	5,00	4,00	5,00	4,00
	Mode	5	5	4	4	5	5	4	5	4
	Std. Dev.	,490	,501	,572	,591	,526	,464	,417	,540	,580
Cadmos	Median	5,00	5,00	5,00	5,00	2,00	5,00	4,00	4,00	4,00
	Mode	5	5	5	5	2	5	4	4	4
	Std. Dev.	,405	,405	,501	,506	,501	,490	,427	,404	,392

Source: created by the authors

According to Table X, most participants value the potential of all design tools for describing the learning activities (E11_a), although 12.5% exhibit a moderate attitude towards the eXe Learning tool's capabilities. Generally, with an agreement or strong agreement above 80%, teachers appear satisfied with how the tools depict the learning resources in the scenarios (E11_b), except for the Learning Designer tool, where 47,5% of participants disagree with the statement, and 40% express a moderate opinion about its adequacy. Furthermore, the majority of teachers agree or strongly agree that the Learning Designer (70%), eXe Learning (90%), LAMS (100%), edCrumble (95%), and Cadmos (100%) satisfactorily support the visual representation of activities (E11_c). Regarding how the tools connect learning outcomes with activities (E11_d), most participants are satisfied with LAMS, edCrumble, and Cadmos. In more detail, 60% of the participants believe that eXe Learning is suitable, while 40% disagree or strongly disagree with the Learning Designer's effectiveness. Teachers' opinions on the visual representation of resources (E11_e) indicate a moderately optimistic view, with both the Learning Designer and Cadmos tools receiving equal ratings of 42.5%. In contrast, 57.5% of participants express disagreement regarding Cadmos. For the remaining tools, the study shows agreement or strong agreement (80%) with the statement about the visual representation of resources (E11_e). Overall, most participants show agreement or strong agreement that all design tools facilitate the representation of the design during the authoring phase (E11_h/>85%), provide a transparent flow model of the instructional design (E11_g/>70.0%), and illustrate the connection between resources and activities (E11_f/>77.5%). Specifically, teachers maintain a neutral stance on whether the Learning Designer (55%) and eXe Learning (42.5%) tools offer a fully graphical representation of the learning design (E11_i).

As shown in Almost all the participants agree or strongly agree that a learning design can be implemented automatically or semi-automatically in an LMS (Moodle) using the Learning Designer or Cadmos tools (E13_c). However, they all disagree or strongly disagree that this can be done by the tool itself using LAMS or edCrumble. Participants' opinions on this option are mixed concerning the eXe Learning tool. Expressly, 50% agree, 20% disagree, and 30% remain neutral about the abovementioned option (E13_c). The way the learning design tools guide participants during the implementation/sharing phase divides them (E13_d). In this question, teachers responded regarding the overall guidance of the tools during the implementation/sharing phase, which is why a large percentage expressed a neutral position on this matter. Nearly all teachers agreed or strongly agreed that the Learning Designer, LAMS, and edCrumble tools support sharing learning designs online (E13_e). However, they strongly disagreed on whether the eXe Learning and Cadmos tools fulfill this function.

Table XI for question 12, participants' responses highlighted various aspects of the tools they have or would like to have to enhance their ability to represent the design during the authoring/design phase.

The survey's part for the implementation/sharing phase (statements E13_a—E13_g) offers a comprehensive illustration of the teachers' reactions to each tool, as shown by the descriptive frequency analysis in Table XII. The agreement rates in Table XIII provide insights into the overall trend for implementing the design for learning and reveal potential discrepancies among participants.

According to Table XIII, more than 67.5% of the participants agree or strongly agree that all LD tools allow the export of designs in various formats (E13_a). Furthermore, almost all participants seemed satisfied with the tools' guidance for exporting the design (E13_b), except for LAMS, where teachers expressed moderate satisfaction (32.5%) regarding this option.

Table X. Distribution of responses in the authoring/design phase

		E11a	E11b	E11c	E11d	E11e	E11f	E11g	E11h	E11i
Tool		%	%	%	%	%	%	%	%	%
Learning Designer	Strongly disagree	0	2,5	0	67,5	0	0	0	0	0
	Disagree	0	47,5	2,5	32,5	15,0	5,0	0	0	5,0
	Neither agree nor disagree	0	40,0	27,5	0	42,5	17,5	7,5	0	55,0
	Agree	32,5	10,0	70,0	0	42,5	77,5	80,0	47,5	40,0
	Strongly agree	67,5	0	0	0	0	0	12,5	52,5	0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
eXe Learning	Strongly disagree	0	0	0	0	0	0	0	0	0
	Disagree	0	7,5	0	0	12,5	2,5	5,0	5,0	20,0
	Neither agree nor disagree	12,5	12,5	10,0	40,0	7,5	7,5	25,0	10,0	42,5
	Agree	75,0	80,0	80,0	60,0	80,0	90,0	70,0	72,5	37,5
	Strongly agree	12,5	0	10,0	0	0	0	0	12,5	0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
LAMS	Strongly disagree	0	0	0	0	0	0	0	0	0
	Disagree	0	0	0	0	0	0	0	2,5	0
	Neither agree nor disagree	0	5,0	0	0	10,0	5,0	15,0	10,0	2,5
	Agree	52,5	47,5	30,0	47,5	80,0	85,0	70,0	82,5	27,5
	Strongly agree	47,5	47,5	70,0	52,5	10,0	10,0	15,0	5,0	70,0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
edCrumble	Strongly disagree	0	0	0	0	0	0	0	0	0
	Disagree	0	0	0	0	0	0	0	0	0
	Neither agree nor disagree	0	0	5,0	5,0	2,5	0	5,0	2,5	5,0
	Agree	37,5	42,5	57,5	50,0	27,5	30,0	82,5	32,5	55,0
	Strongly agree	62,5	57,5	37,5	45,0	70,0	70,0	12,5	65,0	40,0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Cadmos	Strongly disagree	0	0	0	0	0	0	0	0	0
	Disagree	0	0	0	0	57,5	0	0	0	0
	Neither agree nor disagree	0	0	0	0	42,5	0	2,5	2,5	7,5
	Agree	20,0	20,0	42,5	47,5	0	37,5	80,0	82,5	85,0
	Strongly agree	80,0	80,0	57,5	52,5	0	62,5	17,5	15,0	7,5
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Source: created by the authors

Almost all the participants agree or strongly agree that a learning design can be implemented automatically or semi-automatically in an LMS (Moodle) using the Learning Designer or Cadmos tools (E13_c). However, they all disagree or strongly disagree that this can be done by the tool itself using LAMS or edCrumble. Participants' opinions on this option are mixed concerning the eXe Learning tool. Expressly, 50% agree, 20% disagree, and 30% remain neutral about the abovementioned option (E13_c). The way the learning design tools guide participants during the implementation/sharing phase divides them (E13_d). In this question, teachers responded regarding the overall guidance of the tools during the implementation/sharing phase, which is why a large percentage expressed a neutral position on this matter. Nearly all teachers agreed or strongly agreed that the Learning Designer, LAMS, and edCrumble tools support sharing learning designs online (E13_e). However, they strongly disagreed on whether the eXe Learning and Cadmos tools fulfill this function.

Table XI. Given answers to the open-ended question during authoring/design phase

LD Tool	Response Category (responses included more than one category)	Frequency
Learning Designer	Inability to link resources to the activity.	9 (22,5%)
	There is a restriction on the different types, with only the web and file resources supported.	6 (15%)
	The graphical representation of the resources uses a design like a binder for all the resources in the scenario.	8 (20%)
	The representation of scenario flow is verbal.	7 (17,5%)
	None	10 (25%)
eXe Learning	The representation of scenario flow is verbal.	14 (35%)
	Ability for graphical representation of resources.	5 (12,5%)
	None	21 (52,5%)
LAMS	The representation of scenario flow is graphical.	24 (60%)
	None	16 (40%)
edCrumble	Ability to link to various resources to activities.	10 (25%)
	The design of the activities follows Bloom's taxonomy.	5 (12,5%)
	The representation of scenario flow is graphical.	8 (20%)
	The effective guidance offered by the tools facilitates the authoring phase	7 (17,5%)
	None	10 (25%)
CADMOS	Inability to graphical representation of resources.	8 (20%)
	The representation of scenario flow is graphical.	14 (35%)
	None	18 (45%)

Source: created by the authors

Table XII. Tool support for teachers' design decisions in the implementation/sharing phase

Tool		E13a	E13b	E13c	E13d	E13e	E13f	E13g
Learning Designer	Median	5,00	5,00	4,00	4,00	5,00	4,00	5,00
	Mode	5	5	4	4	5	4	5
	Std. Dev.	,474	,496	,304	,423	,504	,506	,405
eXe Learning	Median	4,00	4,00	3,50	3,50	2,00	1,00	1,00
	Mode	4	4	4	3	2	1	1

	Std. Dev.	,496	,464	,791	,716	,350	,439	,385
LAMS	Median	4,00	4,00	1,00	4,00	4,00	1,00	2,00
	Mode	4	4	1	4	4	1	2
	Std. Dev.	,506	,554	,439	,506	,452	,221	,597
edCrumble	Median	4,00	4,00	2,00	4,00	5,00	4,00	4,00
	Mode	4	4	2	4	5	4	4
	Std. Dev.	,474	,379	,452	,496	,474	,389	,464
Cadmos	Median	4,00	4,00	4,00	4,00	2,00	2,00	4,00
	Mode	4	4	4	4	2	2	4
	Std. Dev.	,490	,572	,506	,452	,405	,405	,501

Source: created by the authors

Finally, the answers converge regarding the satisfaction level with the tools' statistical analysis of the learning activities utilized in the educational scenario.

Table XIII. Distribution of responses in the implementation/sharing phase

		E13 a	E13 b	E13 c	E13 d	E13 e	E13 f	E13 g
Tool		%	%	%	%	%	%	%
Learning Designer	Strongly disagree	0	0	0	0	0	0	0
	Disagree	0	0	0	0	0	0	0
	Neither agree nor disagree	0	0	10,0	0	0	0	0
	Agree	32,5	40,0	90,0	77,5	45,0	52,5	20,0
	Strongly agree	67,5	60,0	0	22,5	55,0	47,5	80,0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0
eXe Learning	Strongly disagree	0	0	0	0	10,0	75,0	82,5
	Disagree	0	0	20,0	5,0	87,5	25,0	17,5
	Neither agree nor disagree	0	2,5	30,0	45,0	2,5	0	0
	Agree	60,0	75,0	50,0	42,5	0	0	0
	Strongly agree	40,0	22,5	0	7,5	0	0	0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0
LAMS	Strongly disagree	0	0	75,0	0	0	95,0	15,0
	Disagree	2,5	0	25,0	0	0	5,0	65,0
	Neither agree nor disagree	22,5	32,5	0	47,5	0	0	20,0
	Agree	75,0	62,5	0	52,5	72,5	0	0
	Strongly agree	0	5,0	0	0	27,5	0	0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0
edCrumble	Strongly disagree	0	0	27,5	0	0	0	0
	Disagree	0	2,5	72,5	0	0	2,5	0
	Neither agree nor disagree	32,5	5,0	0	40,0	0	2,5	0
	Agree	67,5	92,5	0	60,0	32,5	92,5	70,0
	Strongly agree	0	0	0	0	67,5	2,5	30,0
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Cadmos	Strongly disagree	0	0	0	0	20,0	20,0	0
	Disagree	0	0	0	0	80,0	80,0	0
	Neither agree nor disagree	0	5,0	2,5	27,5	0	0	0
	Agree	62,5	57,5	67,5	72,5	0	0	57,5
	Strongly agree	37,5	37,5	30,0	0	0	0	42,5
	Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Source: created by the authors

Specifically, concerning the statistical analysis capability regarding the time required by each learning activity (E13_f), almost all teachers reported that the Learning Designer and edCrumble tools provided this functionality satisfactorily. In contrast, they were not as enthusiastic about the capabilities of eXe Learning, LAMS, and Cadmos. Regarding the ability to statistically analyze the activities used in an educational scenario (E13_g), all the participants indicated that this is supported by the Learning Designer, edCrumble, and Cadmos tools, but not by eXe Learning and LAMS.

As shown in Table XIV for question 14, participants' responses focused on various aspects of the tools they have or would like to have to enhance design representation during the implementation-sharing phase.

Table XIV. Given answers to the open-ended question during implementation/sharing phase

LD Tool	**Response Category (responses included more than one category)**	**Frequency**
Learning Designer	It provides the ability to implement the design in the LMS (Moodle) directly and easily.	27 (67,5%)
	None	13 (32,5%)
eXe Learning	It allows for to implementation of the design in the LMS (Moodle) easily, even if not directly.	11 (27,5%)
	It does not provide a statistical analysis.	12 (30%)
	It does not offer the ability to share the designs.	4 (10%)
	None	13 (32,5%)
LAMS	It offers the ability to share the designs.	24 (60%)
	Ability to implement the scenario in its own LMS	5 (12,5%)
	None	11 (27,5%)
edCrumble	It provides statistical analysis.	21 (52,5%)
	It outputs an interactive visualization with a shared URL that other teachers can adapt and reuse.	6 (15%)
	None	13 (32,5%)
CADMOS	It does not offer the ability to share the designs.	8 (20%)
	It does not provide a statistical analysis of the type of activities.	14 (35%)
	None	18 (45%)

Source: created by the authors

V. Discussion

The research examines the capabilities of five popular learning design tools and explores the added value these tools offer in supporting the learning design lifecycle, as perceived by teachers [29]. In particular, it focuses on how the tools Learning Designer, eXe Learning, LAMS, edCrumble, and

Cadmos support the design phases that arise when representing an educational scenario [18].

When the different tools represented the given scenario, teachers had to modify the design decisions presented in the scenario. This was due to the tools' inability to support specific functions, as indicated by their responses and suggestions in the questionnaire. The findings, illustrated in Table XV, provide valuable insights into how these tools support learning design. They are meant to assist teachers in choosing the right learning design tool to inform their decisions.

Regarding the first research question related to the conceptualization phase, the teachers in this study highly valued the ability to capture the scenario's metadata. The participants emphasized that Learning Designer and Cadmos are particularly effective tools for capturing the scenario's name, description, and duration in separate fields. This result is also confirmed by the study of [47].

Table XV. Learning design tools features

LD		Features for scenario representation	Learning Designer	eXe Learning	LAMS	edCrumble	Cadmos
CONCEPTUAL	METADATA	Scenario Title					
		Scenario Description					
		Scenario Duration					
		Classification of Activity Types					
		Formulation of Learning Objectives					
		Learning Scenario Roles					
		Teaching Methods (Educational theories and approaches - patterns)					
		Teaching Offering Methods (In classroom, distance, etc.)					
		Declaration of Cooperative Activities					
		Declaration of Independent Learning (Presence - absence of teacher)					
	GUIDANCE	Guidance In Conception (Existence of appropriate frameworks, help)					
		Description of Cognitive Objectives (proposal of verbs or taxonomy)					
		Description of Metacognitive Objectives (Proposal of verbs or taxonomy)					
AUTHORING / DESIGN		Description of Activities					
		Description of Resources					
		Graphical Representation of Activities					
		Linking Activity with Objectives					
		Graphical Representation of Resources					
		Attaching Resources					
		Linking Resource with Activity					
		Scenario Flow Representation (Visual)	Verbal	Verbal	Graphical	Graphical	Graphical
		Guidance In Designing (Existence of appropriate frameworks, help)					
IMPLEMENTATION / SHARING		Design Export					
		Online Design Repository					
		Implementation In LMS (Moodle)	Direct	Indirect			Direct
		Statistical Analysis by Time					
		Statistical Analysis by Type of Activities					
		Guidance In Implementation (Existence of appropriate frameworks, help)					

Source: created by the authors

Furthermore, the Learning Designer received positive evaluations as the sole research tool that allows teachers to articulate the scenario's cognitive and metacognitive learning outcomes, guiding them by suggesting specific vocabulary from the taxonomy. This feature aligns with the research of [34], who emphasize the importance of well-defined learning objectives in the design process. It also corresponds with the findings of [48], which showed that participants value a Learning Designer tool that supports a theory-based articulation of learning objectives.

Additionally, it was stated that the tool's design approach requires teachers to use only one pedagogical theory based on [49] Conversational Framework. As a result, the tool restricts the options to the six types of learning activities, as also mentioned in [50] research. In the study, tools such as eXe Learning and LAMS received mixed feedback, particularly regarding their ability to classify activities according to a taxonomy and the lack of distinct fields for capturing the scenario's name, description, and duration. While some tools offer clear guidance, others may need to improve their flexibility in representing scenarios [31]. Overall, the teachers in this study strongly emphasized the significance of learning objectives and well-defined concepts in ensuring effective learning design, as observed in [51] in her research.

Concerning the second research question related to the authoring phase, the study assessed teachers' satisfaction with the guidance provided by these tools. It arrived at the same conclusion as [37] that practical guidance facilitates the authoring phase. Furthermore, Learning Designer, edCrumble, and Cadmos were particularly effective in describing learning activities and resources. However, the Learning Designer was unable to describe resources, negatively impacting its evaluation. Such a finding contradicts the research of [34].

On the other hand, the study aligns with [33], suggesting that the capabilities of learning design tools to support the creation and representation of innovative activities enhance educators during the design process. All tools received favorable evaluations for their ability to link learning objectives to activities, as supported in [52], who emphasized that aligning objectives with activities is crucial for ensuring teaching clarity and coherence. This study highlighted that the edCrumble, LAMS, and Cadmos tools support a fully graphical representation of the learning design, as did the research in [53], which identified LAMS and Cadmos as graphical tools. This contrasts with the verbal representation of the scenario provided by the Learning Designer and eXe Learning tools.

Finally, concerning the third research question related to the implementation and sharing phase, which involves exporting designs and their direct application in LMS (Moodle), Learning Designer, and Cadmos, these systems received high scores. The research aligns with the findings of [34] and [53]. These tools were positively evaluated for their ability to export designs in various formats and facilitate implementation in LMS platforms (Moodle). Moreover, [31] argue in their research that transitioning from design to implementation in an LMS remains a barrier for educators. However, the tools LAMS and eXe Learning were rated poorly due to they did not have statistical analysis capabilities regarding the duration and the type of learning activities, indicating a need for improvement in this area. This oservation is consictent with previous research highlighting the importance of visual analytics in learning design, as it enables teachers to evaluate and reflect on their design decisions, allowing them to adjust and improve their designs accordingly.

VI. Conclusion

The study examines how five design tools support the phases of a learning design life cycle. It compares and emphasizes the features of various design tools in representing a design for learning through these phases. It identifies the characteristics of these tools to help teachers determine which tool is most suitable for articulating their design decisions more accurately.

We have highlighted the tools' features, using them to represent an educational scenario accurately (Table XV). We have also identified unresolved issues related to representing a design for learning in different phases: conceptual, authoring/design, and implementation/sharing.

Overall, all the learning design tools analyzed in this study effectively supported the visualization of concepts to an acceptable extent. The primary issue is that most tools need to improve in recording metacognitive learning objectives and categorizing the various activity types within a taxonomy. Except for the Learning Designer tool, which does not effectively connect learning outcomes with activities and lacks detail in describing multiple learning resources, all the tools demonstrate the ability to represent learning designs during the authoring phase. Specifically, LAMS, edCrumble, and Cadmos support a graphical representation of the educational scenario, whereas Learning Designer and eXe Learning provide a verbal one. Although the tools can export the design for learning in different formats during the implementation phase, not all facilitate automatic or semi-automatic design implementation in an LMS. Additionally, not all can share designs for further collaboration with other teachers. The information presented in Table XV can assist teachers in selecting and adopting the appropriate learning design tool to represent their design for learning throughout its life cycle.

Given the rapid advancement of technology and the emergence of new learning design tools, similar research could be conducted on additional tools to enrich the Table XV by capturing the features of more authoring tools. This will help teachers in consciously and intentionally integrate the design for learning process with the support of digital tools into their daily practice, as well as assist them in selecting the appropriate tools that accurately reflect their design decisions.

Facilitating the learning design process by selecting suitable digital tools also encourages the sharing of learning designs within the educational community. It provides opportunities to evaluate and modify them for use in a variety of contexts, eventually disseminating genuine prototype designs for learning and best practices.

VII. Limitations And Future Work

The current case study is based on a single educational scenario with a relatively small sample size (40 teachers). Although this constraint may impact the generalization of the findings, the study provides an interesting foundation for future research. It paves the way to use the proposed approach in broader educational contexts and diverse subject areas. Research extensions like that could improve the credibility of the conclusions and reveal potential differences in the effectiveness of the tools.

Also, studies that use larger samples and report effect sizes and confidence intervals by utilizing inferential statistical analyses, could provide more precise insights about the significance and the reliability of detected differences.

Moreover, measuring teachers' perceptions not only immediately after workshops but also after applying the tools in real classroom practice would offer stronger evidence of their long-term usefulness.

Finally, incorporating comparative tables and a wider variety of experimental or simulation-based results, ideally supported by computational models, could significantly improve the clarity, depth, and originality of future analyses.

References

[1] G. Conole, M. Dyke, M. Oliver, and J. Seale, ‘Mapping pedagogy and tools for effective learning design’, *Computers & Education,* vol. 43, no. 1, pp. 17–33, Aug. 2004, doi: 10.1016/j.compedu.2003.12.018.

[2] G. N. H. Nguyen and M. Bower, ‘Novice teacher technology-enhanced learning design practices: The case of the silent pedagogy’, *British Journal of Educational Technology,* vol. 49, no. 6, pp. 1027–1043, 2018, doi: 10.1111/bjet.12681.

[3] D. Persico and F. Pozzi, ‘Informing learning design with learning analytics to improve teacher inquiry’, *British Journal of Educational Technology,* vol. 46, no. 2, pp. 230–248, 2015, doi: 10.1111/bjet.12207.

[4] B. Rienties and L. Toetenel, ‘The impact of learning design on student behaviour, satisfaction and performance: A cross-institutional comparison across 151 modules’, *Computers in Human Behavior,* vol. 60, pp. 333–341, Jul. 2016, doi: 10.1016/j.chb.2016.02.074.

[5] S. Bennett, S. Agostinho, and L. Lockyer, ‘Technology tools to support learning design: Implications derived from an investigation of university teachers' design

practices', *Computers & Education,* vol. 81, pp. 211–220, Feb. 2015, doi: 10.1016/j.compedu.2014.10.016.

[6] S. Bennett, S. Agostinho, and L. Lockyer, 'The process of designing for learning: understanding university teachers' design work', *Education Tech Research Dev,* vol. 65, no. 1, pp. 125–145, Feb. 2017, doi: 10.1007/s11423-016-9469-y.

[7] D. Hernández-Leo et al., *'An Integrated Environment for Learning Design',* Frontiers in ICT, vol. 5, 2018, [Online]. https://www.frontiersin.org/articles/10.3389/fict.2018.00009 (Accessed Date: December 28, 2023).

[8] V. Svihla, R. Reeve, O. Sagy, and Y. Kali, 'A fingerprint pattern of supports for teachers' designing of technology-enhanced learning', *Instr Sci,* vol. 43, no. 2, pp. 283–307, Mar. 2015, doi: 10.1007/s11251-014-9342-5.

[9] S. A. Triantafyllou and Y. Farhaoui, 'Learning Design of Lesson Plans with LAMS and CADMOS', in Artificial Intelligence, Big Data, IOT and Block Chain in Healthcare: From Concepts to Applications, Y. Farhaoui, Ed., *Cham: Springer Nature,* Switzerland, 2024, pp. 103–111.

[10] T. Trust and E. Pektas, 'Using the ADDIE Model and Universal Design for Learning Principles to Develop an Open Online Course for Teacher Professional Development', *Journal of Digital Learning in Teacher Education,* vol. 34, no. 4, pp. 219–233, Oct. 2018, doi: 10.1080/21532974.2018.1494521.

[11] S. Agostinho, 'The use of a visual learning design representation to support the design process of teaching in higher education', *Australasian Journal of Educational Technology,* vol. 27, no. 6, Art. no. 6, Sep. 2011, doi: 10.14742/ajet.923.

[12] B. Wasson and P. A. Kirschner, 'Learning Design: European Approaches', *TechTrends,* vol. 64, no. 6, pp. 815–827, Nov. 2020, doi: 10.1007/s11528-020-00498-0.

[13] S. McKenney, Y. Kali, L. Markauskaite, and J. Voogt, 'Teacher design knowledge for technology enhanced learning: an ecological framework for investigating assets and needs', *Instructional Science,* vol. 43, no. 2, pp. 181–202, 2015.

[14] J. Dalziel et al., 'The Larnaca Declaration on Learning Design', *Journal of Interactive Media in Education,* vol. 1, no. 7, pp. 1–24, 2016.

[15] D. Celik and G. D. Magoulas, 'A Review, Timeline, and Categorization of Learning Design Tools', in Advances in Web-Based Learning – ICWL 2016, D. K. W. Chiu, I. Marenzi, U. Nanni, M. Spaniol, and M. Temperini, Eds., in Lecture Notes in Computer Science. *Cham: Springer International Publishing,* 2016, pp. 3–13. doi: 10.1007/978-3-319-47440-3_1.

[16] D. Persico et al., 'Learning design Rashomon I - supporting the design of one lesson through different approaches', *Research in Learning Technology,* vol. 21, Sep. 2013, doi: 10.3402/rlt.v21i0.20224.

[17] D. Persico, F. Pozzi, and P. Goodyear, 'Teachers as designers of TEL interventions', *British Journal of Educational Technology,* vol. 49, no. 6, pp. 975–980, 2018, doi: 10.1111/bjet.12706.

[18] L. P. Prieto et al., 'Learning design Rashomon II: exploring one lesson through multiple tools', *Research in Learning Technology,* vol. 21, Sep. 2013, doi: 10.3402/rlt.v21i0.20057.

[19] F. M. Dagnino, Y. A. Dimitriadis, F. Pozzi, J. I. Asensio-Pérez, and B. Rubia-Avi, 'Exploring teachers' needs and the existing barriers to the adoption of Learning Design methods and tools: A literature survey: Teachers' needs and barriers to adoption of LD', *Br J Educ Technol,* vol. 49, no. 6, pp. 998–1013, Nov. 2018, doi: 10.1111/bjet.12695.

[20] M. Bower and P. Vlachopoulos, 'A critical analysis of technology-enhanced learning design frameworks', *British Journal of Educational Technology,* vol. 49, no. 6, pp. 981–997, 2018, doi: 10.1111/bjet.12668.

[21] P. M. M. Ghislandi and J. E. Raffaghelli, 'Forward-oriented designing for learning as a means to achieve educational quality', *British Journal of Educational Technology,* vol. 46, no. 2, pp. 280–299, 2015, doi: 10.1111/bjet.12257.

[22] Goddard, T., Griffiths, D., Mi, W. (2015). Why has Ims Learning Design not Led to the Advances which were Hoped for?. In: Maina, M., Craft, B., Mor, Y. (eds) The Art & Science of Learning Design. *Technology Enhanced Learning.* SensePublishers, Rotterdam. https://doi.org/10.1007/978-94-6300-103-8_9.

[23] Y. Mor, B. Craft, and D. Hernández-Leo, 'Editorial: The art and science of learning design', *Research in Learning Technology,* vol. 21, Sep. 2013, doi: 10.3402/rlt.v21i0.22513.

[24] Y. Mor and O. Mogilevsky, 'Learning Design Studio: Educational Practice as Design Inquiry of Learning', in Scaling up Learning for Sustained Impact, D. Hernández-Leo, T. Ley, R. Klamma, and A. Harrer, Eds., in *Lecture Notes in Computer Science.* Berlin, Heidelberg: Springer, 2013, pp. 233–245. doi: 10.1007/978-3-642-40814-4_19.

[25] L. P. Prieto, P. Tchounikine, J. I. Asensio-Pérez, P. Sobreira, and Y. Dimitriadis, 'Exploring teachers' perceptions on different CSCL script editing tools', *Computers & Education,* vol. 78, pp. 383–396, Sep. 2014, doi: 10.1016/j.compedu.2014.07.002.

[26] S. Karga and M. Satratzemi, "Evaluating Teachers' Perceptions of Learning Design Recommender Systems," in Transforming Learning with Meaningful Technologies, *Lecture Notes in Computer Science,* vol. 11722, Cham: Springer, 2019, pp. 98–111. doi: 10.1007/978-3-030-29736-7_8.

[27] G. Conole and S. Wills, 'Representing learning designs – making design explicit and shareable', *Educational Media International,* vol. 50, no. 1, pp. 24–38, Mar. 2013, doi: 10.1080/09523987.2013.777184.

[28] J. A. Muñoz-Cristóbal, L. P. Prieto, J. I. Asensio-Pérez, I. M. Jorrín-Abellán, and Y. Dimitriadis, 'Lost in

Translation from Abstract Learning Design to ICT Implementation: A Study Using Moodle for CSCL', in 21st Century Learning for 21st Century Skills, A. Ravenscroft, S. Lindstaedt, C. D. Kloos, and D. Hernández-Leo, Eds., in *Lecture Notes in Computer Science.* Berlin, Heidelberg: Springer, 2012, pp. 264–277. doi: 10.1007/978-3-642-33263-0_21.

[29] F. Pozzi, J. I. Asensio-Pérezc, and D. Persico, 'The Case for Multiple Representations in the Learning Design Life Cycle', in The Future of Ubiquitous Learning: Learning Designs for Emerging Pedagogies, B. Gros, Kinshuk, and M. Maina, Eds., *in Lecture Notes in Educational Technology.* Berlin, Heidelberg: Springer, 2016, pp. 171–196. doi: 10.1007/978-3-662-47724-3_10.

[30] J. I. Asensio-Pérez, Y. Dimitriadis, L. P. Prieto, D. Hernández-Leo, and Y. Mor, 'From idea to VLE in half a day: METIS approach and tools for learning co-design', in *Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality,* Salamanca, Spain: ACM, Oct. 2014, pp. 741–745. doi: 10.1145/2669711.2669983.

[31] F. Pozzi, J. I. Asensio-Perez, A. Ceregini, F. M. Dagnino, Y. Dimitriadis, and J. Earp, 'Supporting and representing Learning Design with digital tools: in between guidance and flexibility', *Technology, Pedagogy and Education,* vol. 29, no. 1, pp. 109–128, Jan. 2020, doi: 10.1080/1475939X.2020.1714708.

[32] K. A. Papanikolaou, E. Gouli, K. Makrh, I. Sofos, and M. Tzelepi, 'A Peer Evaluation Tool of Learning Designs', in *Adaptive and Adaptable Learning,* K. Verbert, M. Sharples, and T. Klobučar, Eds., Cham: Springer International Publishing, 2016, pp. 193–206. doi: 10.1007/978-3-319-45153-4_15.

[33] D. Laurillard, E. Kennedy, P. Charlton, J. Wild, and D. Dimakopoulos, 'Using technology to develop teachers as designers of TEL: Evaluating the learning designer', *British Journal of Educational Technology,* vol. 49, no. 6, pp. 1044–1058, 2018, doi: 10.1111/bjet.12697.

[34] E. Zalavra and K. Papanikolaou, 'Exploring the Potential of the Learning Designer as a Teacher Support Tool', *Electronic Journal of e-Learning,* vol. 17, no. 2, pp. 107–117, 2019.

[35] L. Albó and D. Hernández-Leo, 'edCrumble, a Data-Enriched Visual Authoring Design Tool for Blended Learning', *IEEE Transactions on Learning Technologies,* vol. 14, no. 1, pp. 55–68, Feb. 2021, doi: 10.1109/TLT.2020.3040475.

[36] F. Dağ, L. Durdu, and S. Gerdan, 'Evaluation of Educational Authoring Tools for Teachers Stressing of Perceived Usability Features', *Procedia - Social and Behavioral Sciences,* vol. 116, pp. 888–901, Feb. 2014, doi: 10.1016/j.sbspro.2014.01.316.

[37] J. I. Asensio-Pérez et al., 'Towards teaching as design: Exploring the interplay between full-lifecycle learning design tooling and Teacher Professional Development', *Computers & Education,* vol. 114, pp. 92–116, Nov. 2017, doi: 10.1016/j.compedu.2017.06.011.

[38] D. Hernández-Leo, J. I. Asensio-Pérez, M. Derntl, L. P. Prieto, and J. Chacón, 'ILDE: Community Environment for Conceptualizing, Authoring and Deploying Learning Activities', in Open Learning and Teaching in *Educational Communities,* C. Rensing, S. de Freitas, T. Ley, and P. J. Muñoz-Merino, Eds., Cham: Springer International Publishing, 2014, pp. 490–493. doi: 10.1007/978-3-319-11200-8_48.

[39] J. Chacón-Pérez, D. Hernández-Leo, Y. Mor, and J. I. Asensio-Pérez, 'User-Centered Design: Supporting Learning Designs' Versioning in a Community Platform', in The Future of Ubiquitous Learning: Learning Designs for Emerging Pedagogies, B. Gros, Kinshuk, and M. Maina, Eds., in *Lecture Notes in Educational Technology*, Berlin, Heidelberg: Springer, 2016, pp. 153–170. doi: 10.1007/978-3-662-47724-3_9.

[40] T. Huizinga, N. Nieveen, and A. Handelzalts, "Implementation Activities in Design Teams: Opportunities to Demonstrate and Acquire Design Expertise," in *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning,* Springer, Cham, 2019, pp. 187–204. doi: 10.1007/978-3-030-20062-6_10.

[41] M. Bower, B. Craft, D. Laurillard, and L. Masterman, *'Using the Learning Designer to develop a conceptual framework for linking learning design tools and system',* Jan. 2011, pp. 61–71.

[42] P. Goodyear and Y. Dimitriadis, 'In medias res: Reframing design for learning', *Research in Learning Technology,* vol. 21, Sep. 2013, doi: 10.3402/rlt.v21i0.19909.

[43] K. S. Taber, 'The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education', *Res Sci Educ,* vol. 48, no. 6, pp. 1273–1296, Dec. 2018, doi: 10.1007/s11165-016-9602-2.

[44] A. Abu-Al-Aish and S. Love, 'Factors Influencing Students' Acceptance of M-Learning: An Investigation in Higher Education', *irrodl,* vol. 14, no. 5, Art. no. 5, 2013, doi: 10.19173/irrodl.v14i5.1631.

[45] J. R. Lewis, 'IBM computer usability satisfaction questionnaires: Psychometric evaluation and instructions for use', *International Journal of Human–Computer Interaction*, vol. 7, no. 1, pp. 57–78, Jan. 1995, doi: 10.1080/10447319509526110.

[46] A. McKennell, 'Attitude Measurement: Use of Coefficient Alpha with Cluster or Factor Analysis', *Sociology,* vol. 4, no. 2, Art. no. 2, 1970.

[47] M. Katsamani, S. Retalis, and M. Boloudakis, 'Designing a Moodle course with the CADMOS learning design tool', *Educational Media International,* vol. 49, Dec. 2012, doi: 10.1080/09523987.2012.745771.

[48] E. Zalavra, K. Papanikolaou, Y. Dimitriadis, and C. Sgouropoulou, 'Representing learning designs in a

design support tool', *Educ Inf Technol*, vol. 28, no. 6, Art. no. 6, Jun. 2023, doi: 10.1007/s10639-022-11441-6.

[49] D. Laurillard, 'A conversational framework for individual learning applied to the "Learning Organisation" and the "Learning Society"', *Systems Research and Behavioral Science*, vol. 16, no. 2, pp. 113–122, 1999, https://doi.org/10.1002/(SICI)1099-1743(199903/04)16:2%3C113::AID-SRES279%3E3.0.CO;2-C.

[50] O. Oyekola, *'Using Laurillard's learning types as a lens for course design in a chemical engineering undergraduate course'*, 2023.

[51] D. Modlinger, '*eLearning and mobile learning - concept and script : handbook for media authors and project managers /*'. Springer, Wiesbaden, 2024.

[52] B. Czerkawski, 'AI and the Learning Experience Design: From Divergent Creativity to Convergent Precision', *TechTrends*, vol. 69, no. 2, pp. 260–270, Mar. 2025, doi: 10.1007/s11528-024-01032-2.

[53] S. A. Triantafyllou, Y. Farhaoui, N. Khouibiri, and T. Ahajjam, 'Conceptualizing the Learning Design of lesson plans with LAMS and CADMOS', Salud, Ciencia y Tecnología - Serie de Conferencias, vol. 2, pp. 471–471, Oct. 2023, doi: 10.56294/sctconf2023471.

APPENDIX

Evaluation Scale for Learning Design Tools in the Representation of Learning Scenarios

Response Format: Five-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, 5=Strongly Agree)

CONCEPTUAL

9. How much do you agree or disagree with each of the following?

a) The design tool offers the ability to clearly describe the application context of the educational scenario (title, description, audience, etc.).
b) The design tool offers the ability to define all learning objectives clearly.
c) The guidance provided by the design tool for correctly describing the learning objectives is satisfactory.
d) With the design tool, I can clearly define the roles mentioned in my educational scenario.
e) The design tool offers functions that adequately support the integration of various learning theories, methods, or strategic approaches (PBL, cooperative learning, pyramid strategy, FC, TPS, etc.).
f) The design tool supports how educational scenarios are offered (in-class or distance learning).
g) The design tool supports the ability to declare the presence or absence of the teacher during the enactment of the scenario.
h) The design tool supports the ability to characterize individual or group activities.
i) The design tool allows for defining a clear schedule of the scenario's learning activities execution.
j) The guidance the design tool provides for correctly describing metacognitive learning objectives is satisfactory.
k) The design tool adequately supports the classification of learning activities by type.
l) The overall guidance offered by the design tool in the conceptual phase is satisfactory.

10. Suggestions and comments for including functions or features in the tool that will better facilitate the representation of the design for learning in the conceptual phase:

AUTHORING / DESIGN

11. How much do you agree or disagree with each of the following?

a) The learning activities of the scenario are satisfactorily described in the design tool.
b) The way the design tool describes the learning resources of the scenario is satisfactory.
c) The design tool offers a graphical representation of activities.
d) The design tool supports linking objectives to activities.
e) The representation of the learning resources by the design tool is done graphically.
f) The design tool provides the ability to link learning resources to activities.
g) Design decisions and the flow of the educational scenario are graphically represented comprehensively.
h) The guidance offered by the design tool in the authoring phase is suitable.
i) The design tool supports turning my ideas into a fully graphical design.

12. Suggestions for including functions or features in the tool that would facilitate the representation of the design in the Authoring phase:

IMPLEMENTATION / SHARING

13. How much do you agree or disagree with each of the following?

a) The design tool facilitates exporting learning designs in various formats.
b) The guidance provided by the design tool for exporting designs is satisfactory.
c) The design tool provides the ability to implement my design in the LMS easily.
d) The guidance offered by the design tool in the implementation phase is suitable.
e) The design tool offers the ability to share (online) my designs for learning.
f) The design tool provides statistical analysis capabilities in terms of learning activities' duration.
g) The design tool provides statistical analysis capabilities by learning activity type.

14. Suggestions for including functions or features in the tool that would facilitate the implementation and sharing of the designs for learning.

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- Aglaia Psani was responsible for conducting the study, collecting and analysizing the data, and drafting the original text.
- Georgia Kiriakaki contributed to the writing process and assisted with the organization and presentation of results.
- Christos Kitagias formulated the initial idea of the research and guided its overall design and course, while also undertaking the scientific supervision of the project.
- Ioannis Psaromiligos provided methodological support and participated in the correction and strengthening of the text.
- Ioannis Salmon and Konstantinos Kyprianos confirmed the correctness of the analytical procedures and helped to clarify and understand the findings.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

This manuscript was funded by the special account for research grants of the University of West Attica.

Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.