Learner eXperience Design Guidelines: Proposal and a Preliminary Evaluation with Experts

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Abstract. *Derived from User Experience (UX), Learner Experience (LX) focus on perceptions and responses during the use of computational resources in education. Literature reveals that few elements are considered in LX, impeding comprehensive understanding and effective learning experiences. To address this gap, we proposed the Design Guidelines to support LX (LEDG) in educational activities. This paper outlines the methodology for creating LEDG using Design Science Research (DSR). Experts in Computing evaluated LEDG, resulting in detailed specifications, refinement of design guidelines, and compilation of tool options for teachers. DSR adoption ensures research rigor and evidence-based development, enhancing the proposal's reliability and relevance.*

1. Introduction

Learner eXperience (LX) can be understood as learners' perceptions and responses when participating in activities with computational resources, extending the concept of User Experience (UX) to the educational context [Huang et al. 2019]. The literature defines UX as the preferences, perceptions, emotions, and physical and psychological responses of the user that occur before, during, and after use [Bevan et al. 2016]. Thus, both concepts are related to the quality of the experience an individual has when interacting with computational resources.

Similar to UX, LX comprises elements that refer to the components that guide the LX design, allowing for the inclusion of feelings and emotions in learning. The work of Huang et al. (2019) is one of the few studies found in the literature that present defined elements for working on LX with computational resources, such as Value, Usability, Desirability, Adaptability, and Comfortability. By considering these elements, it is possible to encourage learner motivation [Lister 2021], identify and overcome challenges [Corbalan et al. 2006], as well as propose inclusive and personalized computational resources [Arachchi et al. 2017].

From a Systematic Mapping Study (SMS) [Silva et al. 2024], it was identified that LX technologies are typically developed with a focus on specific contexts and objectives. Significantly, it was observed that several of these technologies have a limited structure regarding LX elements. This limitation makes it difficult to both identify and use different LX elements. Therefore, the main question guiding this research is: "How to design LX considering appropriate elements and technologies to support educational experiences with computational resources?".

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Thus, we proposed LEDG Design Guidelines to support LX in educational activities utilizing computational resources. The aim of this paper is to describe the methodological process for developing LEDG within the framework of Design Science Research (DSR) [Runeson et al. 2020]. Based on the results of SMS (Approach to Understand Problem), LEDG design guidelines were developed in six distinct steps (Approach to Design Solution). A preliminary evaluation was conducted with experts to refine the LEDG before its implementation in a real-world context (Approach to Evaluation Solution).

Through evaluation with experts, it was possible to detail the guidelines using a use case as an example, including general description, objectives, prerequisites for teachers, guidance on organization and application, practical examples, tips, expected results, and suggestions for computational resources. After evaluation, 11 similar guidelines were grouped, and 2 redundant ones were excluded, resulting in a robust list of 22 guidelines. Additionally, 75 options of computational resources were compiled, such as conceptual mapping tools and interactive learning platforms, organized into 25 categories to meet various educational needs.

This work establishes an intersection between the fields of Human-Computer Interaction (HCI) and Educational Informatics, with a focus on LX design. In this way, the research offers benefits to researchers, who can adopt the guidelines to guide the creation of new learner-centered solutions. Additionally, it provides valuable contributions to teachers, who can implement these guidelines in their practices. Similarly, educational technology developers can also use the guidelines to better understand LX in practice, enabling them to create solutions more aligned with teaching and learning processes.

2. Background and Related WorK

LX is an emerging focus area concerned with the UX of learners during technology-mediated learning [Schmidt and Huang 2022]. It targets a specific user class (the learner) engaged in a specific task (related to learning) while using a particular type of technology (a technological tool designed for learning) [Schmidt and Huang 2022]. LX addresses how experiential elements can influence learning effectiveness and how perceptual factors can impact learner performance [Schmidt and Huang 2022]. This perspective aligns with [Dewey 1938]'s ideas about human experience, recognizing that learning is not merely a cognitive process but also an emotional and sensory journey that transforms both the individual and their context.

UX aims to create a more enjoyable interaction between the user and the system. In LX, however, beyond providing a pleasant experience, the use of computational resources must also achieve the educational primary purpose: the assimilation of knowledge [Huang et al. 2019]. Reaching this goal requires a careful balance between cognitive challenges and emotional support, fostering an environment where learners feel confident, motivated, and willing to explore and persist in their activities.

In the work by Magyar and Haley (2020), a collaborative process is described for balancing LX and UX in the development of the Gallery Tool, a web application that facilitates shared work, provides access to peer feedback, and supports courses and assignments. The process includes: a) Requirements gathering with LX Designers (LXDs): The need for the Gallery Tool emerged from discussions between LXDs and MOOC instructors at the University of Michigan, aiming to enhance peer feedback in final activities, a feature not supported by the Coursera platform; b) Design with LXDs: During the design phase, LXDs participated in weekly meetings, contributing to a learner-centered approach. The team adjusted content prioritization based on feedback needs rather than following a chronological order; c) Addition of new pilot use cases with LXDs: At the end of development, LXDs identified two new use cases for the Gallery Tool, deciding to proceed with pilot testing despite some limitations; and d) Conducting and analyzing interviews with learners: Eighteen undergraduate Computer Science students tested the application in three MOOCs and participated in interviews via Google Hangouts.

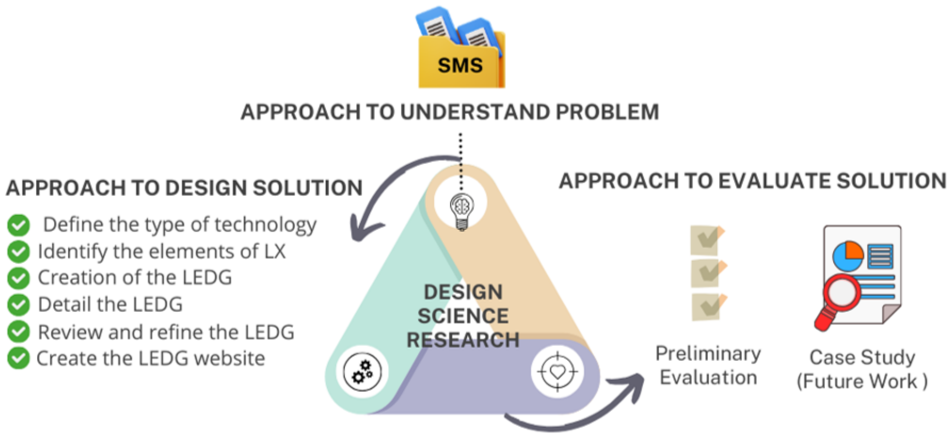
Unlike the guidelines identified in the literature that focus primarily on the design of computational resources, the LEDG guidelines stand out by considering these resources as tools to support educational activities and influence the learner's experience. For example, Luchini et al. (2004) proposed two guidelines for designing learner-centered tools for mobile devices such as tablets and smartphones, while Arachchi et al. (2017) offered 31 guidelines for designing accessible and motivating e-learning environments for learners with Intellectual Disabilities. Similarly to these studies, guidelines related to usability and accessibility are included and adapted in the LEDG guidelines, guiding the choice of resources for educational activities and supporting teachers in LX design.

A key differentiator of the LEDG guidelines proposal is the integration of LX elements. In the cited works, these elements were addressed implicitly, with an emphasis on Value and Usability. For instance, Magyar and Haley (2020) highlight learners' demotivation due to limited interaction and feedback in their activities, leading to a negative perception of computational resources. In contrast, Luchini et al. (2004) and Arachchi et al. (2017) focus exclusively on the computational aspects. Thus, this research underscores the importance of considering not only the technical aspects of using and developing computational resources but also the learners' perceptions and feelings about the activities supported by these resources.

3. Methodological Path

This research was conducted using DSR, a methodological paradigm that guides researchers in conducting rigorous scientific research focused on the development of innovative technologies (Figure 1). Based on the results of the SMS (approach adopted to understand the problems), it was possible to create the solution design process. Thus, firstly, we sought to define the type of technology, opting for guidelines with the purpose of providing clear guidance on specific activities in the educational context [Arachchi et al. 2017]. These guidelines were developed to assist teachers in considering learners' needs, aiming to provide enriching and memorable LX. Additionally, the LEDG aims to facilitate the appropriate selection of computational resources based on real experiences to maximize desired outcomes, such as increased learner engagement and active participation. In the second step, the LX elements identified in SMS were reviewed and related according to their definitions and objectives, aiming to establish a solid and meaningful foundation for the LEDG proposal. The elements highlighted for LEDG were: value (knowledge, contextualization, growth, skills, aptitude), usability (accessibility, technology), desirability (motivation, interests, engagement, pleasure, empowerment), adaptability (personalization, diversity), and comfortability (UX, physiology). In the third step, guidelines were created to reflect the different LX elements [Luchini et al. 2004, Arachchi et al. 2017, Silva et al. 2023]. In the fourth step, the guidelines were detailed, seeking to define the objectives to be achieved, the prerequisites that teachers need to meet to apply them, how to organize them, and how to apply them in an activity, as well as providing tips, expected outcomes, and suggestions for computational resources. In the fifth step, a review and refinement of the guidelines were conducted, with the support of the advisor and co-advisor, which allowed grouping guidelines with similar or complementary characteristics, eliminating repetitive ones, and organizing them in a more logical sequence of use. Finally, in the sixth step, a website was created for teachers to access this material quickly and from anywhere via the internet. The LEDG currently comprises a set of 22 guidelines[1], which represent the technology developed due to the DSR phases. By following the guidelines provided by the LEDG, it is expected that teachers can create and/or redesign educational activities aligned with LX.

Figure 1. Research Visual Abstract.



LEDG underwent preliminary assessment by three experts in the fields of HCI, Informatics in Education, and Software Engineering (Approach to Evaluate Solution). Expert P1 holds a PhD in Informatics and has been actively involved in Informatics in Education and Information Systems, with a focus on Computing and Society. Additionally, he possesses extensive experience as a lecturer and researcher in Computer Science. Expert P2, a PhD in Computer Science, brings expertise as a lecturer and researcher in Computing applied to Education, particularly in Computer-Supported Collaborative Learning. Expert P3, holding a PhD in Systems Engineering and Computing, has a background as a lecturer and researcher in Computer Science, with a specialization in HCI and Software Engineering, particularly focusing on UX, Usability, and Software Quality.

The evaluation process was conducted individually using the ad-hoc technique, allowing each expert to assess the technology based on their own approach and experience, without formal predefined reading procedures [Melo 2009]. This approach was chosen because it acknowledges that each expert can contribute valuable insights based on their unique experience. During the evaluation, the experts had access to the constituent of the LEDG and were encouraged to explore them according to their understanding and experience. They were prompted to analyze the LEDG's structure and content, providing feedback on its clarity and applicability. Subsequently, after individual analysis, the experts were asked to offer their perceptions and comments on the LEDG in textual format. These results underwent qualitative analysis using thematic analysis, enabling the

[1]https://sites.google.com/view/ledguide/home

identification of patterns and emerging themes in the data [Braun and Clarke 2006]. The thematic analysis process included steps such as data familiarization, generation of initial codes, identification of potential categories, and refinement of categories. To ensure the reliability and consistency of the collected data, peer review was conducted.

4. Qualitative Analysis, Improvements and Proposal

This section presents the results of the preliminary evaluation with experts. This study was approved by the Ethics Committee of Federal University of Paraná under CAAE: 67603723.9.0000.0102.

4.1. Regarding the use of the LEDG

Expert P3 noted that the guidelines were abstract (see P3's 1st quote). Expert P2 suggested specifying an input so that teachers can use the guidelines more directly (see P2's 1st quote). She also questioned whether teachers receive clear guidance on how to read and apply the guidelines in their disciplines (see P2's 2nd quote). Additionally, Expert P3 emphasized that it is not clear to teachers how they can apply the guidelines and what the benefit would be (see P3's 2nd quote). Finally, she suggested that the guidelines be reorganized following a pattern for a clearer step-by-step process (see P3's 3rd quote).

"The guidelines are abstract; the teacher can interpret them in any way and apply them as they see fit. As they currently stand, they're not helpful" (P3).

"I suggest specifying an entry point for the teacher. You could consider something more specific: for an activity, not for everything [module or entire course]" (P2).

"Does the teacher have to read all the guidelines alone and decide which ones to use? Always starting from scratch for a new proposal? Is there any guideline that provides a starting point?" (P2).

"How can the teacher instantiate the guidelines for the classroom? What does he need? What will he gain? It's not clear..

"Thinking of the guidelines as a "design pattern", where there can be a standard to be followed by teachers" (P3).

There is a concern about the abstraction of the guidelines, which can hinder their interpretation and practical application by teachers. Thus, the guidelines were detailed, using a use case specification as an example, including general description, their objectives, the prerequisites that teachers need to meet, guidance on how to organize and apply the guidelines in educational activities, providing examples of activities to illustrate their practical application, tips, expected results, and suggestions for computer resources to include in activities were defined. Therefore, a more specific entry for teachers was defined to facilitate their use in specific educational activities, rather than covering an entire module or discipline at once. These procedures were subjected to peer review to ensure their suitability. These measures aim to make the guidelines more accessible and practical for teachers, facilitating their use in designing educational experiences.

4.2. Regarding the content and refinement of the LEDG

The expert P3 noted that the list of guidelines was extensive, which could overwhelm teachers when using it (see P3's first quote). She suggested that guidelines with similar goals be grouped or compiled, making the set more concise and easier to use (see P3's second quote). Additionally, she emphasized the importance of a detailed inspection of the guidelines to ensure that their objectives and expected outcomes were aligned and coherent (see P3's third quote). Expert P1 recommended the inclusion of additional learning design or educational guidelines to enrich and broaden the approach (see P1's quote).

"The list of guidelines is too extensive, which can be exhausting for teachers to read and evaluate" (P3).

"If the objectives are similar, it could be the same guideline, but with different wording. Consider the possibility of merging them in this case" (P3).

"Check if the objectives of the guidelines are consistent with the expected outcomes" (P3).

"The guidelines could be based on issues from LD or education. For example, "allowing the exchange of knowledge and experience" relates to collaborative learning. What guidelines could be drawn from this theory? Not only from SMS, there is a [research] area" (P1).

In response to the extensive list of guidelines, the need to provide options to the teacher was recognized, allowing them to choose the guidelines according to the intended educational experience, but the importance of making the list more manageable was also understood. Therefore, after a process of detailing and refining the guidelines, a thorough inspection was conducted, grouping similar guidelines (N = 11) and excluding those that proved redundant (N = 2), resulting in a leaner and more robust list comprising 22 guidelines, as seen in the Table 1. Additionally, regarding the consideration of guidelines from other areas, it was decided to maintain the focus on guidelines specifically aimed at LX, to ensure their relevance and effectiveness within the scope of the research. Our main goal is to investigate how learners respond to activities with computational resources and whether the proposed guidelines are suitable for them, keeping the focus on the educational experience and established patterns in the specialized literature on LX.

4.3. Regarding including and clarifying computational resources in the design guidelines

Expert P1 emphasized the importance of suggesting tools to teachers as part of the LX design process (see P1's 1st quote). Additionally, Expert P1 recommended conducting research on existing work that has mapped educational tools, highlighting the importance of leveraging existing knowledge and best practices (see P1's 2nd quote). Finally, Experts P3 raised important questions about which computational resources should be considered in LX design, whether those supporting learning or teaching should also be included (see P3's quote).

"I suggest adding a set of tools to the guidelines that support meetings, group work, and scheduling" (P1).

"I suggest gathering the studies that have already mapped these tools, such as those conducted during the pandemic" (P1).

"The resource considered in the guideline is one that helps the learner learn, such as a simulation, or one used as support for the teacher as well, like Moodle?" (P3).

Table 1. LEDG Design Guidelines

Qty.	List of Guidelines (G)
G1.	Foster student accountability by requesting the completion of the educational activity using computational resources.
G2.	Make materials available through computational resources before classes so that students can prepare, take notes on curiosities, ideas, and questions.
G3.	Suggest that the student choose a environment and an appropriate time to carry out activities using computational resources.
G4.	Allow the student to access materials and attend the class on their preferred device, aiming for visual comfort.
G5.	Provide opportunities for students to express themselves and ask questions through computational resources, especially for those who are more shy or have difficulties in educational activities.
G6.	Request feedback from students about their educational experiences before, during, and after using computational resources.
G7.	Explain the content with the aid of computational resources, including images and/or multimedia.
G8.	Provide guidance/steps/tips to assist students during the educational activity through computational resources.
G9.	Allow the student to decide which topics, tools, and educational materials they would like to work with in the educational activities, among the options previously chosen by the teacher.
G10.	Link content, examples, and images to prior skills and knowledge when using computational resources.
G11.	Present the content of the subject in easily readable and understandable terminology within the computational resource.
G12.	Organize the content by themes or topics with the support of computational resources.
G13.	Utilize computational resources that require fewer steps to achieve the educational objective, aiming to avoid excessive complexity.
G14.	Ensure that supporting computational resources are useful and easily visible in the interface to prevent undue frustration for students, yet also challenging enough to engage them consciously
G15.	Utilize computational resources that contain icons and menus with a sufficiently large size to allow for precise pointing.
G16.	Utilize computational resources with a consistent positioning of buttons, menus, forward, backward, print, and save options.
G17.	Utilize computational resources with suitable font and colors, taking into account readability.
G18.	Utilize computational resources with symbols that are known and recognizable by students.
G19.	Utilize computational resources that avoid excessive use of graphics, flashes, and animations that may interfere with student concentration.
G20.	Promote the practical application of learned content in students' daily lives, leveraging available computational resources.
G21.	Promote the exchange of experiences and knowledge among students through computational resources.
G22.	Facilitate the inclusion of a tutor for the student during the use of computational resources, enabling their participation in the educational experience.

In response to these concerns, an online search was conducted to identify and suggest a variety of computational resources that could be incorporated into the guidelines, providing suggestions for the teachers. Currently, 75 options of computational resources have been compiled to promote educational experiences, such as conceptual mapping tools, programming and coding resources, interactive and gamified learning platforms, among others. This diversity of tools has been organized into 25 distinct categories, aiming to meet different educational needs and contexts. Additionally, it was established that both resources aimed at supporting learner learning and those aimed at assisting teacher work would be considered for inclusion in the guidelines. This is justified by the importance of providing teachers with the necessary tools to design meaningful educational experiences, even when it comes to learner experiences.

5. Conclusions and Future Work

This research presented the process of developing the LEDG guidelines, which focus on LX design, using the DSR methodology. In this context, it is important to emphasize that the guidelines focus on the educational experiences of learners. While incorporating practices from different areas, such as collaborative learning and educational design, the guidelines prioritize learners' responses and feelings in the learning process, which can support the improvement of educational activities using computational resources.

For teachers, the guidelines aim to provide support in LX design, enabling them to enhance the quality of educational activities based on educational experiences. This is expected to result in a more meaningful LX for students, where they can actively engage and acquire knowledge more effectively. In the context of Educational Informatics, this research offers guidance on integrating computational resources into the educational process, maximizing their benefits and positive impact on learning. Additionally, the research contributes to the field of HCI by providing guidelines on how computational resources can be better utilized to promote a high-quality LX.

One limitation to consider is the extensive initial list of guidelines. While the quantity was intended to provide teachers with a variety of options for their activities, the refinement process ultimately produced a more concise list. Another limitation is that the research was not applied in a real-world context. For future work, a case study is planned to assess the effectiveness and applicability of the guidelines in a real classroom setting. This will allow for the collection of feedback from teachers and students, the identification of possible improvements and refinements, and the provision of empirical evidence of their utility and effectiveness. The importance of promoting the awareness of LX within the academic and educational community through training, as well as sharing practical resources and materials to assist teachers in implementing the guidelines in their pedagogical practices, is also recognized. Through continued study and the practical adoption of these approaches, it is hoped to drive innovation and continuous improvement in the learning experience for both teachers and students.

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