

A Codesign Strategy for an Iterative and Participatory Game-design for Learners' Agency in Formal Educational Settings.

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Abstract: Games in educational settings allow the enactment of students' agency while facilitating enjoyable and playful learning. Game design is a complex task that has been informed by previous research and structured based on a number of methodologies which mainly include four processes: analysis, development, implementation, evaluation. Based on prior research, this study suggests the complementary role of different backgrounds for game design: game design thinking, co-design strategies and design-based research. Furthermore, the ACAD framework contributes to the enrichment of the pedagogical design by indicating key elements for the epistemic, physical and set, and social dimensions. In this work, we present the iterative cycle where a model of eight phases encompassing this background supports and enhances the game-design process.

Background

A game has been defined as “a physical or mental contest” played under specific rules, with the goal of amusing or rewarding the participant” (Peña-Miguel & Sedano Hoyuelos, 2014). Beyond this initial description, there is a wide network of terms in the field of game science, and while gamification is a term to define the process of using game elements in non-game contexts, following Deterding (2012), other terms refer to an “end result” (Laine & Lindberg, 2020, p. 805), such as serious games or educational game, among others. Students' activity with games can be defined as game-based learning and the quality or state is referred to under the terms gamefulness and playfulness (Laine & Lindberg, 2020). There are many definitions of serious games, and the term was initially used to refer to teaching resources that are efficient for all ages because they are motivating and offer opportunities to explore intellectual and social problems without risk (Peña-Miguel & Sedano Hoyuelos, 2014). More recently, they have been defined as “interactive computer applications, with or without a significant hardware component, that have challenging goals, are fun to play and engaging, incorporate some scoring mechanism, and supply the user with skills, knowledge or attitudes useful in reality” (Bergeron, 2006, p. 28), being the content the serious part of the game (Hammady & Arnab, 2022). The success of a serious game highly depends on its capacity to keep students' motivation and adapting to their needs and interest. Nevertheless, to achieve their aims, tutors are needed to enhance the additional value of the gaming experience of learning (Peña-Miguel & Sedano Hoyuelos, 2014). Games have been described as playful and agentic along with other motivational characteristics of the design (Arnab et al., 2019; Peña-Miguel & Sedano Hoyuelos, 2014; Taub et al., 2020).

The growing impact of games in educational settings for the achievement of learning aims along with their contribution to behavioural and attitudinal change requires a prior rigorous development (Arnab & Clarke, 2017). Designing games that can be motivating in educational settings is a complex process (Laine & Lindberg, 2020). There exist some methodologies for game development, which is a field both highly based on software development and multidisciplinary approaches (Arnab & Clarke, 2017).

In this work, we present a methodological approach that builds upon previous work and adds the value of some specific educational characteristics for the development of serious games or games for formal learning contexts, aligned with the claim by de Freitas who highlights the need to “understand how we learn” (2018, p. 74) in game design. On the one hand, this methodological approach is based on the Game Design Thinking strategy developed by Arnab et al. (2019); and, the contribution by the DALI E+ project partnership, in which games for adult learners on data literacy were developed (Castañeda et al., in press). On the other hand, this current new contribution of a methodological approach builds on research about innovation in education, mainly on the Design Based Research model, which has been successfully in many innovative experiences in the educational technology field (de-Benito & Salinas, 2016), and the co-design learning approach (Gros, 2019; Gros & Durall, 2020), which as a participatory model, structures the participation of diverse agents in the creation process. Furthermore, for the pedagogical design of the games, the Activity-Centred Analysis and Design (ACAD) framework is used to identify the game elements that are related to the epistemic dimension (both from the content part of the game or the game dynamics in itself), the physical elements and set design, and the social relationship among players (Goodyear et al., 2021; Castañeda et al., in press).

Method

The co-design process of educational games is the result of applying design-based research (DBR), which through iterative cycles of design, implementation, analysis and evaluation in different contexts, has allowed the development of a procedure for the co-design of playful learning games. DBR is a contextualised research methodology, oriented towards the resolution of complex problems of the educational practice. It involves a participatory process and uses iterative cycles of design, evaluation, and redesign to develop solutions in the form of artifacts, programs, materials, applications, etc., which address identified needs while also generating design principles that contribute to theoretical knowledge creation (Armstrong et al., 2018, Reeves, 2006).

In the case of this proposal, three iterative cycles have been developed and applied in different contexts, which have allowed refining the procedure for codesigning educational games (Figure 1).

The first cycle was carried out within the context of the DALI E+ project (<https://dalicitizens.eu/>), aimed at the creation of a game-based pedagogical strategy for data literacy in citizenship. In this project, different games were developed through a co-creation process involving participants and target audience, applying the game design thinking strategy, methodology conceived by the research team of Coventry University, Game Changers (<https://gchangers.org>).

As a result of the first cycle, we adapted the strategy in a pre-service teacher training context, incorporating two theories to the procedure: design-based research and the ACADToolkit for educational design.

In the third cycle, the procedure developed with pre-service teachers was applied in a course for in-service teachers professional development, providing valuable information for the implementation in real contexts, such as k-12 levels.

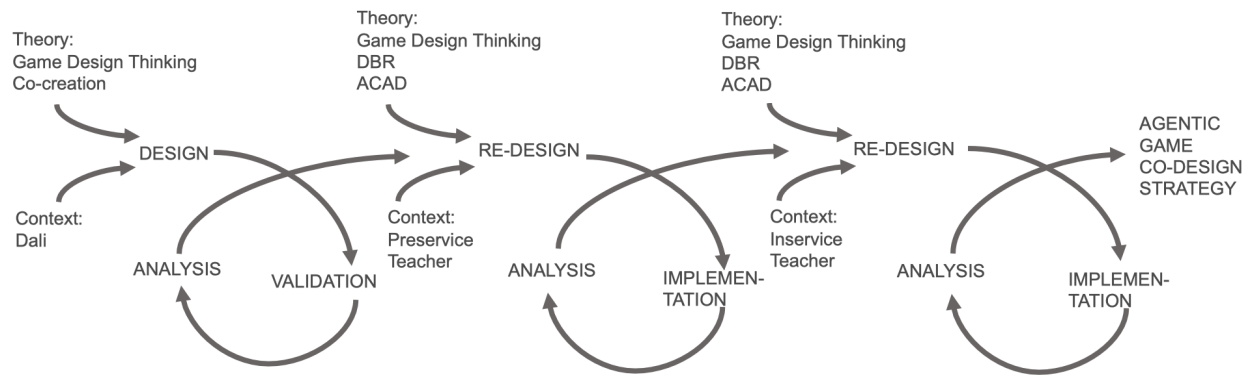


Figure 1. Iterative cycles for the development of the agentic game co-design strategy

Results

The DBR process itself has been the backbone of the co-design strategy for creation of agentic and playful learning games. For this purpose, we have adapted and integrated three key concepts described in the background: game design thinking strategy, ACAD framework and codesign learning approach (on the basis of design based research).

After three iterative cycles, the designed procedure consists of 8 steps:

Step 1. Empathise. The first one, consists of analyzing the context and the needs in order to find solutions through a playful game. This is a participatory process in which, in a collaborative way, designers, teachers or the target audience come up with the first ideas of the game's characteristics, topic and needs to be achieved, such as learning, behavior and competencies. It is advisable to identify whether the game will be in digital or analogue format.

Step 2. Define. In this step the learning plan is defined and articulated. There are some questions to consider like the learning/competencies objectives, the assessment/reflection criteria, tasks, activities, the context of learning or the Universal Design for Learning.

Step 3. Ideate. In order to start thinking about the game, it can be useful to build on previous knowledge and experience of using games in an educational or personal context. Therefore, this step is about getting inspired by existing Play and Games. This includes thinking about: rules, game elements, type of game (collaborative, competitive, individual), achieving the learning goals, ...

Step 4. Game design. In this step the ACAD framework adapted for game design is particularly interesting. It allows identifying the elements in relation to three dimensions: set design, epistemic design and social design. This is the stage when most decisions are made about how the game will be like. Decisions about the epistemic design as the concept of the game and gameplay, the rules, players, conflict, outcomes, learning activities/tasks, techniques or tactics. Also decisions about artifacts, tools and resources needed like game elements, interface, look and feel, game resources, boundaries, story premises, tools. Also, decisions about social design and interaction, characters, number of players, roles or interaction patterns.

Step 5. Prototype. This step is about creating the game. It is important to take into account technical considerations such as what materials or applications will be needed, but also to consider the creation of the technical script that includes all the elements of the game, as well as the interaction and interface.

Step 6. Implementation design. The proposal for classroom implementation is described. It should include the description of the usage context of the game as well as the pedagogical sequence with three stages: before playing the games (Activation), the playing time (Application) and after having played (Reflection).

Step 7. Field piloting. This step involves the game implementation with players and data collection for final evaluation. This is carried out from different perspectives and therefore it may be necessary to use several

assessment instruments and criteria, in terms of usability, learning, fun, easiness, functionality, content, pedagogical design, among others.

Step 8. Validation. Data analysis is carried out and through a process of "validation" and reflection the final decision-making leads to fine-tune game creation.

Conclusion

There exist previous studies for the development of serious games for learning aims, which have in common an ongoing process with four phases (analysis, design, development, and evaluation). Therefore, this study is a contribution to the field by extending the background of the methodological process, which has been informed from different models, as can be observed in Table 1. The result is a strategy of eight steps that scaffolds the design process in a sequence of decisions that allow answering to the needs of players, motivational engagement and the learning context. Additionally, the proposed model includes the analysis about the digital platform. Serious games can also take the form of digital games, and further decisions are needed in this case, such as the platforms to be developed, being discussed at different moments of the design process. The background of the Design Thinking Strategy ensures capturing the essential characteristics of playful learning while collecting the participatory aspects of the DALI project and the co-design approach allows a closer personalization to target users. The iterative process inspired by the DBR allows a cycle of progressive improvement. Additionally, the ACAD framework supports further educational reflections which contributes to the emergence of learning while playing and ensures understanding the educational background of the game. Further research is needed to validate each phase and report on the possibilities of this iterative and participatory game-design process for the enactment of agency of learners in formal educational settings.

Design Based Research	Game Design Thinking CU	Co-design	Agentic Game Co-design UIB
Phase 1. Analysis	Step 1. Empathise	Phase 1. Ideation	Step 1. Empathise
	Step 2. Define		Step 2. Define
Phase 2. Design & Development	Step 3. Ideate 1		Phase 2. Prototyping
	Step 4. Ideate 2	Step 4. Game design	
	Step 5. Prototype	Step 5. Prototype	
Step 6. Implementation design			
Phase 3. Implementation	Step 6. Test	Phase 3. Reflection	Step 7. Field piloting
Phase 4. Evaluation			Step 8. Validation

Table 1. Background of the agentic game-codesign strategy

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