Design Decision-Making and Challenges in Serious Game Development

A Thematic Literature Review

da Silva, R. L., Daniells, E., & Baig, M.

Design Case
Design Challenges
design decisions
Game Design
serious game design
Serious Games

This thematic literature review investigates major design decisions and challenges encountered in the development of serious games (SGs). Our review included 27 articles that present a high level of detail about the design and development of a SG. Patterns identified included collaborative development processes, iterative testing, and strategies for balancing conflicting goals. Core decisions reported pertained to game mechanics, player roles, narrative, and user support. Common challenges included conflicting learning and entertainment objectives, contextual constraints, engagement, and technical issues. Our review emphasizes the importance of stakeholder collaboration, iterative processes, and context-aware design, offering a practice-based lens to guide designers in anticipating common pitfalls and leveraging successful strategies in future SG development.

Introduction

Serious games (henceforth SGs) are games developed for purposes beyond entertainment (Squire, 2006), such as education, training, or awareness that offer unique opportunities for engagement but present intricate design demands. Previous studies identified methods and approaches that can facilitate SG design (e.g. Ávila-Pesántez et al., 2017; Barbosa et al., 2014; Korhonen et al., 2017; Nicholas et al., 2023). Challenges faced by design teams and educators during SG development have also been discussed in the literature (Dimitriadou et al., 2021; Strzalkowski & Symborski, 2017). Researchers have given comparatively less attention to synthesizing major design decision points that SG development teams navigate across contexts. In this investigation, we define major design decisions as consequential choices that shape mechanics, player roles, narrative integration, and user support, as evidenced by downstream changes to the artifact or user experience. Identifying everyday decisions and challenges can help designers understand variables that might otherwise be overlooked during SG creation.

Design cases are academic publications that can be rich sources of contextualized knowledge that details how designed artifacts are created and used in practice (Boling, 2010), with accounts that might diverge from existing models and methodologies (Herriott, 2013). As such, they can be valuable sources of documented design decisions and of the obstacles designers face in practice. Yet, design cases remain largely unexplored as a rich source of data on design practices in context. However, previous analyses of design cases have highlighted their value in capturing the complexity of design processes, particularly as it relates to ethics (e.g. Gray & Boling, 2016; Moore et al., 2025). We hypothesized that a literature review of serious game design cases could provide insight into complex decisions and obstacles that can inform future game design and development practices. Given our focus on patterns of decision-making and challenges, a thematic literature review approach (Horntvedt et al., 2018; McAllister et al., 2020) was deemed appropriate for this paper, as it enabled us to connect across studies to synthesize and generate actionable knowledge.

That said, this article is organized as follows: first, we present a review of the literature on SGs and related design frameworks. Then, the methods for our thematic literature review are offered, including article selection criteria and analytical processes. Our analysis then follows, with the major themes related to design decisions and obstacles reported in SG-related design cases. The analysis is followed by a discussion in which we summarize findings and recommendations and relate them to previous literature. Our conclusion introduces suggestions for future research based on our findings.

Theoretical Framework

This section provides an overview of serious games and the design process they entail. We also introduce existing serious game design frameworks identified in the literature.

Serious Games

Serious games are games that are specifically used (and designed) for a purpose beyond pure entertainment (Glaser et al., 2024; Squire, 2006), such as education or emotional outcomes. Serious games can take many forms: they can take place in the real world, such as tabletop games and place-based simulations. They can also be digital, in 2D, 3D, or virtual reality. The highly interactive nature of serious games can promote affective, social, behavioral, cultural, and cognitive engagement (Plass et al., 2015). In training and education, SGs have been used across various fields, including cybersecurity (Calvano et al., 2023), health education (Sharifzadeh et al., 2019), and science education (Papastergiou, 2009; Ullah et al., 2022). Beyond knowledge acquisition, games have also been found to improve learners' moral reasoning (Huang & Ho, 2018; Wright et al., 2020) and moral sensitivity (Tanner et al., 2022). Serious games have also been used to address mental health disorders (Alaa Abd-alrazaq et al., 2023) and promote community engagement (Flood et al., 2018).

Though the goal of an SG is to provide an experience that goes beyond fun as the central goal, enjoyment can still play a significant role in serious gameplay (Papastergiou, 2009; Plass et al., 2015). Effective SG environments can include components that offer support, immediate system feedback, adaptive challenges, immersive visual and auditory aesthetics, and engaging narratives that motivate continued play (Laine et al., 2020; Nadolny et al., 2020; Plass et al., 2020). Adaptive difficulty and progressive complexity in SGs can increase the likelihood of players remaining engaged as their skills progress (Laine et al., 2020). Integrating learning content into the storyline, that is, implementing endogenous fantasies, can also improve engagement and learning outcomes (Naum & Liu, 2020). Empathetic characters and virtual agents can motivate learners through empathy and increase immersion, while productive collaboration and healthy competition with other players can also enhance the learning experience (Sanchez, 2017).

SG design is often not a straightforward process. A multifaceted approach that integrates game mechanics, educational objectives, and user engagement strategies is necessary (Dimitriadou et al., 2021). A central consideration in the design of SGs is the balance between entertainment and educational content, which can be challenging due to the differing priorities of game design, pedagogy, and simulation fidelity (Arnab et al., 2015; Rooney, 2012). The application of established design principles can significantly improve SG usability and effectiveness, ensuring that the game not only captures players' attention but also achieves its other intended outcomes (Chorianopoulos & Giannakos, 2014). The design process should consider the end user to ensure that the game meets the needs and preferences of its target audience (Beristain-Colorado et al., 2021), and incorporate extensive testing with users and experts (Catalano et al., 2014).

Despite significant advances in identifying key elements of SG design, there remains a notable gap in systematically understanding how these components interact during complex SG design processes across different contexts. For instance, while the literature underscores the importance of balancing entertainment with educational outcomes, few studies have thoroughly examined the strategic decisions and inherent challenges that shape this balance in practice. The present paper seeks to bridge this gap by analyzing major design decisions and challenges in serious game development.

Serious game development models and frameworks

Previous studies have identified various methods and frameworks for serious game design and development. Models and frameworks offer different approaches to creating serious games that balance education and entertainment, at varying development stages (Avila-Pesantez et al., 2017). These models and frameworks can start, for example, from a theory (Arachchililage & Love, 2013), existing development methodologies (Nicholas et al., 2023), or by combining certain specific learning principles with game-based learning (Coleman & Money, 2024).

The co.LAB framework (Jaccard et al., 2021) is a recent example of a framework that can be applied across different contexts. This framework emphasizes a collaborative, multidisciplinary approach to serious game design. The co.LAB framework consists of several phases, including requirements, design, development, and test and evaluation, with distinct "building blocks" that are addressed in each phase. These building blocks facilitate the visualization of each development team member's contribution to the design and development process. A model proposed by Roedavan et al. (2021), inspired by the Game Development Life Cycle (GDLC) model, is divided into analysis, production, testing, and release. In the GDLC model, key decisions emphasize the target learner's interests, a balance in difficulty, and the meaningfulness of the content within the design.

Such models and frameworks can also be developed for specific contexts and different instructional goals. A structured three-phase iterative development framework has been proposed to enhance teamwork, decrease costs, and improve quality in medical education serious games (Olszewski & Wolbrink, 2017). Nicholas et al. (2023) illustrate how a systematic, iterative user-centered development framework can be explicitly applied to alcohol and other drug (AOD) education in high schools. Their model follows a seven-step process, beginning with forming a multidisciplinary development team, defining the problem and user preferences through formative research, and mapping relevant evidence into meaningful gameplay elements. Coleman and Money (2024) developed a student-centered experience framework specifically for designing digital game-based learning (DGBL) environments aligned with student-centered learning (SCL) principles. Their framework systematically integrates seven key tenets of SCL with established pillars of high-quality DGBL, such as empowering learners through game co-design and structured problem-solving sequences.

Design frameworks and models provide structure and guidance in the design process, but they inherently have limitations in anticipating challenges. One major limitation is the tension between rigidity and flexibility: frameworks often standardize processes, thereby limiting adaptability (Laursen & Hasse, 2019). Another challenge concerns the context-specific nuances that more general models and frameworks might overlook (Moore, 2021; Smith & Boling, 2009). Since models and frameworks tend to abstract processes to be broadly applicable, they might be limited in addressing unique contextual variables that could significantly impact the design.

Methods

Research Questions

Our thematic literature review of design cases addressed the following questions:

1) What types of major decisions are made by designers in the design and development process of a serious game?

2) What types of challenges do designers face in the design and development process of a serious game?

Literature Search

The thematic literature review process begins with the establishment of clear search criteria aligned with the investigation's purposes (Horntvedt et al., 2018; McAllister et al., 2020). Given our focus on transparent discussions of serious game design processes, we searched the literature using the terms “serious game” and “design case” on Google Scholar (357 results). These search terms were established after initial searches using other terms, such as "serious game" AND "design process" and “serious game” AND "development”, which were not effective at capturing literature describing development processes themselves, but rather empirical studies and conceptual frameworks. The chosen terminology also increased the likelihood that we would find articles that provided a high level of detail on design processes, including thick descriptions and negative case analysis, as these are criteria established to assess the quality of a design case (Boling & Smith, 2009). We also searched for “game” in the International Journal of Designs for Learning (henceforth IJDL), a journal specializing in design cases (53 results). The simplified search term used in the IJDL search was adopted as the journal inherently focuses on design cases of artifacts used in instruction. Though there were no exclusion criteria regarding publication dates, given the novelty of the design case literature, the earliest article selected for this literature review was published in 2009.

We reviewed the abstracts of the 410 results to assess if papers met the criteria for inclusion for this study: 1) these papers included extensive and transparent information about context and SG design and development practices, including failures and crucial decisions made throughout, 2) the articles focused on the design of games created for an objective other than pure entertainment, and 3) articles were written in English. After initial abstract-level screening, we discarded articles that focused on gamification, simulations, or games created solely for entertainment purposes. We then read the remaining articles to assess whether the paper provided a high level of detail on the design and development processes for the SG(s) discussed. In this step, articles that provided only brief descriptions of the SG(s) for the contextualization of a research study were discarded. A total of 27 papers met the inclusion criteria for the study after this selection process. Though most articles selected for this review are explicitly framed as design cases, papers that presented findings of empirical studies in addition to a high level of detail about the development of the SG used for the intervention, including major decisions and challenges, were included in our review, such as Castro-Sánchez et al. (2019), Cederved et al. (2022), De Grove et al. (2010), Menestrina et al. (2021), Rouault et al. (2020), and Seo et al. (2013).

Article Analysis

After the paper selection process was finalized, the lead researcher extracted relevant information from each article. Game descriptions, genres, target audiences, design and development tools, and materials used were captured. This researcher also extracted key design decisions and challenges from each case, deductively coding excerpts from each article as “Major Decisions” or “Challenges” (Braun & Clarke, 2006). Significant decisions and challenges were considered as those that had a considerable impact on the design process and experiential outcomes. As such, each code was reviewed and adjusted across multiple readings of each specific paper, as the impact of each decision or challenge was often not clear until design changes or implementation were discussed in those articles. After this step, the other two researchers reviewed the extracted information to ensure its accuracy. Major design decisions and challenges were renegotiated based on these researchers’ interpretations of their impact on the serious game design approach and the resulting artifact(s). The lead researcher and another researcher then inductively coded the design decisions and challenges from the initially extracted design case excerpts using the qualitative analysis software MAXQDA (Braun & Clarke, 2006). Descriptive words were used to code the nature of decisions and the type or source of challenges. Discrepancies in code interpretation were resolved through consensus discussions and, when necessary, consultation with the third researcher. Finally, these two coders organized codes into relevant themes.

Table 1

Sample Codes, Excerpts, and Themes

Sample Code	Excerpt	Theme

DecisionCollaboration	“By means of participatory action research, children and their parents participated in the development of a serious game about radiotherapy. Nine children (7-10 years old) were included, each with an accompanying parent.” (from Cederved et al., 2022)	Design and Development as Collaborative Efforts
DecisionFeedback	“The entertainment value of spells—especially accidental ones—provided an alternative reward to failure: humor. Many of the most entertaining and memorable moments in play resulted from miscasts.” (from Gabai & Berland, 2021)	Strategies to Provide Support and Reduce the Learning Curve
ChallengeContext	“During our tests in different classrooms, we noticed that contextual factors strongly differed between classrooms in terms of social interaction, infrastructure and IT and educational support” (from De Grove et al., 2010)	Navigating Characteristics and Limitations of Context of Play
ChallengeComplexity	“One persistent design challenge had to do with creating opportunities for players to engage in higher levels of programming such as conditionals and loops, rather than being limited to just simple movements. We wanted to encourage players to use such advanced functions but at the same time make the game accessible to both novice and returning players. As revealed in our earlier prototypes, this was difficult to achieve.” (from Yang & Kopcha, 2022)	Managing Distinct Types of Design Objectives

Ethical Considerations

We adhered to ethical principles throughout the research process. As our analysis focused solely on design cases and published literature, all data were sourced from publicly available, peer-reviewed publications, and no primary data involving human participants were collected. Consequently, institutional review board (IRB) review and approval were not required.

Despite the secondary nature of our data, we took several measures to ensure ethical integrity: i) we ensured that all sources were cited correctly and attributed, respecting the intellectual property rights of the original authors; ii) our data extraction and coding processes were documented in detail, and multiple researchers independently reviewed the extracted information to mitigate individual biases. Discrepancies were resolved through consensus in discussions, which strengthened the reliability of our review; iii) given that the cases often discuss challenges, we exercised caution to accurately represent the contexts and findings of the original studies without misinterpretation or overgeneralization; and iv) although our study did not involve sensitive or confidential data, we remained mindful of the ethical responsibility to avoid any potential harm to the reputations or intellectual contributions of the authors of the original articles.

Results

We found that the selected articles discussed serious games that varied in format (18 digital, 8 analog, and 1 hybrid) and targeted diverse audiences, including school-age students, undergraduates, professionals, medical patients, and museum visitors. All but two of the articles, da Silva (2020) and van Niekerk (2017), described design and development processes that were collaborative in nature. The serious games discussed were developed using a variety of tools and resources, including game engines, software, coding languages, and physical materials and spaces for analog games. The table below presents the game format and genre, target audience, and development tools and materials used in the development of each serious game.

Table 2

General Details of the SGs Discussed

Article	Game Format and Genre	Target Audience	Development Tool(s) and Materials
Anupam et al. (2020)	2D platformer computer game	Undergraduate Students	Not specified
Castro-Sánchez et al. (2019)	Digital simulator	Hospital prescribers	Not specified
Cederved et al. (2022)	Digital simulator	Children preparing to undergo radiotherapy	Not specified
Clark et al. (2016)	Digital marble game	Middle School Students	Unity Engine
Da Silva (2020)	Digital role-playing game	Interest-based	RPG Maker MV
Gabai & Berland (2021)	Tabletop cooperative role-playing game	Interest-based	Physical materials
Gatti Junior et al. (2020)	Board game	School-age Students, Interest-based	Physical materials
Gaydos (2021)	Analog card game	Middle School Students	Physical materials
Gee et al. (2020)	Analog games	Middle School-age Girls	Physical materials
Gottlieb & Schrieber (2020)	Tabletop and mobile game	High School Students and Undergraduates	Physical materials, digital platforms not specified
Hammer & Turkington (2021)	Tabletop role-playing game	Interest-based	Physical materials
Lara et al. (2010)	Educational simulation	Undergraduate Students	Adobe Flex Builder, ActionScript, PHP, MySQL
Law & Jacobsen (2015)	Alternate reality (AR) role-playing game	Undergraduate Students	Second Life (a Multi-User Virtual Environment or MUVE)

Menestrina et al. (2021)	Narrative-focused, cognitive training	Children Ages 8-13 with developmental dyslexia	Not specified
Mochizuki et al. (2021)	Digital role-playing simulation game	Professionals	Low-fidelity prototypes were created using replaceable materials such as paper and plastics
Pereira & Roque (2009)	Digital resource management game	Museum visitors	Unnamed rapid prototyping platform for multiplayer online games
Prestopnik (2016)	Digital action role-playing game	Middle-school-age boys	HTML5 canvas element and Phaser
Radtke (2020)	Digital strategy game	Elementary school Students from underserved communities	Not specified
Rennar-Potacco et al. (2020)	Educational simulation	Undergraduate students	HTML4, HTML5, Javascript
Rouault et al. (2020)	Analog strategy, simulation game	Professionals	Physical materials, calculation tool in Excel
Seo et al. (2013)	Digital motion-based game	Professionals, Medical Patients	Not specified
Sinclair & Livingstone (2016)	Digital simulation game	Professionals	Unity3D, CPN Tools for Petri Net Model
Squire (2021)	Digital role-playing game	Undergraduate Students	Unity
Staller et al. (2020)	Place-based self-defense training game	Professionals	Physical environment and props
Tadayon et al. (2012)	Digital simulation game	Interest-based	Not specified
Van Niekerk (2017)	Digital adventure puzzle game	Primary school children	Not specified
Yang & Kopcha (2022)	Tabletop board game	Children in grades 3 to 5, adults interested in learning the basics of block-based programming to support young children in learning CS skills	Markers, crayons, sticky notes, play-dough, small toys, and standard board game components

What types of major decisions are made by designers in the design and development process of a serious game?

Our thematic literature review revealed several key types of major design decisions. The articles analyzed characterize the SG design process as primarily collaborative and iterative efforts in which major decisions are made regarding player support, guidance, and feedback. Establishing the role of the player and how they are positioned in a narrative is also crucial. Key decisions are also made to balance the often-contrasting entertainment and instructional objectives. We discuss the main themes identified in our review next.

Design and Development as Collaborative and Iterative Efforts

Decisions were made to establish a collaborative design process that involved students and other relevant stakeholders. Cederved et al. (2022), for example, involved child patients and their guardians in the development process, emphasizing co-creation to reduce anxiety and foster understanding of radiotherapy. Menestrina et al. (2021) "engaged several stakeholders, including children, psychologists, game designers, and developers" (p. 2), explicitly framing this process as story co-creation to support children's emotional engagement and comprehension. Rouault et al. (2020) relied on winegrower and extension officer input in a participatory eco-design process, using life-cycle assessment (LCA) to ensure the game design reflected authentic practices. As far as design processes are concerned, most cases reported designs resulting from iterative processes. Mochizuki et al. (2021) emphasize the role of testing and feedback in refining their digital role-playing game. Testing was also key in Yang and Kopcha's (2022) design case, which reflected a pedagogical tension between novice accessibility and more advanced programming concepts. Playtest sessions with graduate students and one 5th-grade student took place to identify potential improvements to game and learning design. Collaboration with different experts was also crucial to ensure content accuracy in Sinclair and Livingstone's (2016) design, which uniquely integrated Petri Nets, a mathematical modelling technique, into serious game modeling.

Strategies to Provide Support and Reduce the Learning Curve

Decisions related to reducing the learning curve by providing player support were also highlighted in several design cases. These strategies can be implemented with in-game features or peer or instructor facilitation. Hammer and Turkington (2021) provided a game book to facilitate game management. Course instructor facilitation was a crucial aspect of the AR role-playing experience designed by Law and Jacobsen (2015), which explicitly aimed to promote climate change literacy. Testers of Castro-Sánchez et al. (2019) game for hospital prescribers also highlighted the need for support for game content and gameplay guidance, building on findings from co-design workshops with multidisciplinary stakeholders. Lara et al. (2010), Seo et al. (2013), and Tadayon et al. (2012) describe efforts to reduce the learning curve, while also noting that tutorials and dialogues could disrupt flow if overly time-consuming, by providing simple and/or tailored interfaces to facilitate navigation for different user profiles. Seo et al. (2013), for instance, offer different interfaces for two distinct professional roles, as well as for patients who interacted with the game.

Interactive Design, Guidance, and Player Feedback

Design cases also included major decisions regarding game mechanics. In van Niekerk's (2017) serious game aimed at teaching the Xhosa language, conversations with non-playable characters served as the primary instructional mechanic. Anupam et al. (2020) and Menestrina et al. (2021) included avatar choice options in their designs to increase player identification with characters and avoid stereotypical depictions. Squire (2021) leveraged seven astronomy tools for in-game tasks and based mission design on these tools. Gabai & Berland's (2021) tabletop game included gesture creation and interpretation as core mechanics to support the research goal of studying meaning-making through physical actions, positioning humor and spell miscasts as a pedagogical support strategy, as well as entertainment.

Strategies for providing in-game guidance and feedback were also discussed. Feedback included in the games reported in the literature was implicit, mechanical, and instructional. Gabai and Berland (2021), for example, opted for implicit feedback by addressing failed spellcasting with humorous outcomes. Rennar-Potacco et al.'s (2020) design included evaluative scores in addition to explicit guidance via prompts and hints. In-game interactions facilitated guidance and feedback in Staller et al.'s (2020) place-based game. Data captured from players' physical motions was used to provide instant user feedback via steadiness and power bars in Tadayon et al.'s (2012) golf game.

Player Control and Narrative

Player-controlled entities ranged from more abstract characters, such as a manager in Pereira & Roque's (2009) geographical management game, to customizable (e.g., Anupam et al., 2020; Menestrina et al., 2021) or pre-determined characters with their own gender and personality (e.g., da Silva, 2020; Hammer & Turkington, 2021). Characters with pre-defined visuals aimed at providing the player with an alternative perspective, such as a health condition (da Silva, 2020) or a specific identity during a real-world-based event (Hammer & Turkington, 2021). Narratives were incorporated into games to foster engagement and increase appeal to the target audience. For example, Law and Jacobsen's (2015) game centered on a mystery narrative that players navigated, adding a layer of problem-solving to the design to capture players' attention. Gee et al.'s (2020) games included narratives that embedded computational thinking concepts in analog form and "in which players could play active roles in addressing social problems or helping others, and that involved both collaboration and competition" (p. 19), which they found to relate to middle school-age girls' interests. Serious game narratives also drew inspiration from existing works, such as Squire's (2021) reported influences of the Firefly Series and Star Wars in a mission-based space role-playing game (RPG).

Reconciling Instruction and Entertainment

Cases that discussed serious games designed for instructional purposes presented major decisions about integrating instructional content with mechanics and narrative. Staller et al. (2020) and Seo et al. (2013) designs focused on providing an experience akin to a real setting, such as a clinic, or real situation, such as knife attacks and patient-medical staff interactions. Radtke et al. (2020) used real-world documents to ensure that the instruction in their strategy game met educational standards. Designed missions (Squire, 2021), in-game problem-solving (Law & Jacobsen, 2015), and in-game interactions (van Niekerk, 2017) were other strategies to ensure entertainment and instructional objectives were aligned.

What types of challenges do designers face in the design and development process of a serious game?

The design cases analyzed point to persistent challenges in serious game design. Contrasting objectives and contextual limitations were discussed as significant obstacles. Player engagement was also an issue identified in some cases. Technical issues also negatively impacted testing sessions. The major obstacles identified in our review are discussed in the sub-sections below.

Managing Distinct Types of Design Objectives

Balancing educational (or another type of intervention goal) and entertainment objectives is discussed as an issue in several designs. For instance, in Gottlieb and Schreiber's (2020) and Yang and Kopcha's (2022) designs, a high level of design complexity was required to ensure that learning objectives were met. Content accuracy and narrative can also be difficult to balance with a sense of play (Gee et al., 2020; Hammer & Turkington, 2021; Gatti Junior et al., 2020; Squire, 2021). Gatti Junior et al. (2020), for example, discuss the challenge of simulating a society within their board game, which required simplification and prioritization processes, refined across multiple iterations and testing sessions, all within the broader aim of sustainability education through modular game design. Designing mechanics that achieve distinct objectives was discussed as an obstacle (Gee et al., 2020).

Navigating Characteristics and Limitations of Context of Play

Our analysis also highlights challenges in managing contextual variables, such as target audience, place of play, resources, and time, across design, testing, and play. Clark et al. (2016) discuss the difficulty in making games, often played voluntarily in casual environments, suitable for the formal, time-constrained classroom setting. Such time constraints required Gottlieb and Schrieber (2020) to adjust the length and complexity of their tabletop and mobile games so they could be entirely played in one class session. These adjustments might not be sufficient in all cases, however, as Pereira and Roque (2009) discuss the difficulty of teaching game mechanics to learners with less gaming experience within that short amount of time. Furthermore, the lack of available resources presented an obstacle in different design cases. Radtke et al.'s (2020) reliance on a single coder and the coder's limited coding skills constrained the implementation of specific game mechanics envisioned by the design team. The lack of available financial resources for development required that Gaydos' (2021) game be simplified, thereby affecting design decisions. Design possibilities were impacted by contextual demands, such as extensive documentation processes, in Squire's (2021) serious game.

Capturing or Maintaining Player Interest and Engagement

The obstacles to serious game adoption can start with players' pre-defined understanding of games. Castro-Sánchez et al. (2019) discuss one of their findings in testing sessions and co-design workshops: "potential end-users may reject the tool simply based on their ideas about a game as a ludic experience rather than 'proper' training" (p. 16). Moreover, several cases described the difficulty of maintaining player engagement and ensuring a desired flow of gameplay in testing sessions, with decreasing interest as the play experience progressed. While players were initially engaged in the game experience, Gee et al. (2020) reported a decline in learners' interest over time. Replayability was compromised by sign recognition as the experience unfolded in Gabai and Berland's (2021) game. Features inherent to games, such as tutorials (Lara et al., 2010) and dialogue with in-game characters (Prestopnik, 2016), had a negative impact on players due to their time-consuming nature during testing sessions.

Addressing Technical Problems

Finally, usability issues presented challenges in the testing phase. Navigation problems led players to miss portions of the game (Cederved et al., 2022) and experience difficulties with core mechanics (Law & Jacobsen, 2015). Game visuals also presented obstacles, as Lara et al. (2010) reported a need to improve their user interface, and Clark et al. (2016) required special focus on visuals to ensure clear representation of content in-game.

Discussion

Our analysis reveals that design decisions and challenges in SG development are deeply intertwined, with one often shaping or amplifying the other. Collaborative and iterative design processes, for instance, were central to many projects to ensure authentic content and user-centered outcomes. These same processes, however, exposed contextual constraints, such as time and resource limitations, which, in turn, influenced the feasibility and scope of design decisions. Similarly, decisions to provide extensive player support, tutorials, and feedback were intended to reduce learning curves and sustain engagement. While these mechanisms addressed immediate usability needs, they occasionally disrupted flow and reduced replayability, creating engagement challenges in some cases. That said, decisions related to player support strategies simultaneously mitigated and generated obstacles related to motivation and immersion.

Decisions about game mechanics, narrative, and role definition can also be directly linked to technical and conceptual challenges. Design complexity contributed to content accuracy and engagement but also introduced usability issues, such as navigation difficulties and visual clarity problems. Moreover, attempts to weave instructional content into narratives highlighted the tension between education and entertainment.

Our findings lead us to the following conclusions and make the following recommendations:

(i) *A collaborative SG design process that involves a diverse range of stakeholders, such as educators, subject matter experts, and end-users, from the outset can increase the likelihood of success.* Such practices help ensure the game reflects authentic, evidence-based practices and meets the specific needs of its target audience(s). The importance of collaboration is also emphasized in the game design frameworks previously discussed (e.g., Jaccard et al., 2021; Nicholas et al., 2023).

(ii) *The cases we analyzed do not approach SG design as a one-time event, but rather as a process of continuous improvement.* That said, equally important is the adoption of iterative design processes that incorporate regular testing and feedback cycles, as also discussed in Nicholas et al.'s (2023) framework. By refining game mechanics, narrative elements, and instructional content through repeated playtesting sessions with varied populations, designers can ensure that the game evolves to better meet both its educational and entertainment objectives. Maintaining a balance between these objectives is essential, as the non-complementary nature of these goals often poses challenges in aligning instructional content with engaging gameplay. This balance needs to be a focus on the development process, as in Roedavan et al. (2021) and Nicholas et al.'s (2023) frameworks.

(iii) *Designing tailored, user-friendly game interfaces and providing robust support systems can reduce the learning curve of a game experience.* The articles analyzed achieved this by implementing in-game features, such as tutorials, or by providing external facilitation from instructors or peers. Effective in-game feedback is also vital in digital games. A mix of implicit and explicit feedback can guide players effectively, reinforcing learning while keeping the gameplay engaging. All in all, it is important to consider mechanisms that assist players throughout the game experience from both mechanics and learning standpoints.

(iv) *SG designers must also manage contextual variables such as target audience characteristics, available resources, the setting for play, and time constraints.* Our results surface tensions that conflict with the assumptions embedded in the frameworks reviewed. Co.LAB (Jaccard et al., 2021), and GDLC-inspired models Roedavan et al. (2021) treat context of play largely as background consideration. Educational environments, for example, present a complex challenge as resources and social dynamics can vary from one classroom to another (de Grove et al., 2010). Adapting the design process to accommodate these real-world constraints can enhance the overall effectiveness of both the game's educational and entertainment aspects. Olszewski & Wolbrink's (2017) design framework, for instance, emphasizes cost reduction. Finally, sustaining player engagement and ensuring a smooth flow of gameplay require continuous monitoring of pacing and interaction quality, as well as incorporating varied game mechanics that maintain interest over time, especially if a longer engagement is necessary to achieve the intended learning objectives. Our analysis thus suggests the need for an explicit contextual analysis and constraint-planning phase to increase the likelihood that SG design frameworks are effective across different contexts of play.

Conclusion

This study presented a thematic literature review of design cases focused on the development of serious games. For our review, we focused on major design decisions and challenges encountered during the design and development process. Our review revealed that designers make pivotal choices in areas such as collaborative processes, iterative testing, game mechanics, narrative integration, and the alignment of instructional content with gameplay. At the same time, the cases highlight challenges such as balancing educational objectives with engaging play, managing diverse audience needs, and adapting to constraints, including limited resources and time.

Our findings indicate that SG designers adopt iterative, user-centered processes that foreground practical design decisions, from refining core game mechanics and interface elements to crafting immersive narrative and feedback systems, while navigating contextual constraints and resource limitations. The insights provided by the analysis of design cases offer context-

specific guidance that highlights practices in context and potential pitfalls in serious game development. SG designers are encouraged to leverage these real-world examples to continuously prototype and test games, ensuring that each design choice effectively balances engagement with serious impact. We suggest that further research explore the interplay between cultural, contextual, and resource variables and how these factors shape iterative design decisions, drawing on rich, real-world examples from design cases of serious games and other instructional artifacts. Advancements in Artificial Intelligence (AI) also present an opportunity for researchers to investigate how this technology can be leveraged in and influence decision-making and problem-solving in SG design. Moreover, there is a need to develop standardized methodologies for capturing and codifying the contextualized design knowledge inherent in design cases, which can then inform scalable, resource-efficient frameworks for different types of design.

Our thematic literature review, however, is subject to limitations. First, identifying what counted as "major" design decisions and "challenges" required interpretive judgment in our research group. Although we mitigated this through multi-coder review and consensus discussions, our research subjectivities may still have shaped what was surfaced as consequential. Second, we did not employ a formal rubric to operationalize the significance of decisions and challenges. Future thematic literature reviews of design cases could include the development and application of explicit rating criteria of the importance of decisions to strengthen reliability. Lastly, our search strategy privileged the term "design cases," which may have inadvertently excluded relevant accounts of comparable design work labeled differently in other disciplines or published in other venues and languages; expanding terminology and sources could potentially lead to the identification of other categories of major decisions and challenges.

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