

Designing Serious Games for Libraries: Aligning Educational and Persuasive Intent for Anxiety Mitigation and Heritage Engagement

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Abstract. Libraries occupy a unique niche within the GLAM sector, yet users often face emotional barriers that hinder engagement. This article explores the integration of three design frameworks: the Four-Dimensional Framework, Learning Mechanics–Game Mechanics, and Persuasive Systems Design, to create serious games for libraries. By aligning pedagogical goals with specific game mechanics and persuasive strategies, the authors argue for a hybrid design approach that prioritizes learner autonomy and emotional safety. The study emphasizes that ethical, non-punitive design is essential for maintaining institutional trust and transforming intimidated visitors into confident, capable library participants.

Keywords: Serious Games, Library Anxiety, Cultural Heritage, Persuasive Design, Pedagogical Alignment, Gamification Ethics.

1 Introduction

Libraries are frequently grouped with galleries, archives, and museums within the broader GLAM category, but they function within a distinctive institutional and operational context. Unlike institutions that primarily exhibit objects, libraries combine educational, cultural, and public service functions, centering much of their activity on textual cultural heritage. In recent decades, public libraries have also expanded their social role by hosting events, workshops, literature readings, and exhibitions, making the physical library space an increasingly important part of community life rather than merely a storage site for books (Barclay, 2017; Khan et al., 2022).

This expanded mission is complicated by the persistent phenomenon of “library anxiety”. Mellon defined library anxiety as a form of intimidation and embarrassment experienced in library use, linking it to unfamiliarity with spaces and procedures, technological difficulty, low confidence, and discomfort in approaching staff (Mellon, 1986; Bostick, 1992; Carlile, 2007). A serious game (SG) designed for the library domain must therefore address more than factual learning. It should help users understand the

building, services, rules, and the available collections; practice concrete skills such as navigation in the library space and catalogue use; and reduce hesitation and insecurity. In other words, the intervention must target cognitive, procedural, affective, and behavioral outcomes at the same time.

For that reason, the task of designing a library-oriented SG cannot be treated as a purely instructional problem. It requires alignment across three distinct but interdependent layers: 1) the broad educational and contextual logic of the intervention, 2) the translation of learning goals into gameplay, and 3) the persuasive mechanisms that support behavioral change, motivation, confidence, and continued engagement. Three theoretical SG development frameworks are especially useful for these tasks, but each operates at a different level and has a particular focus. **The Four-Dimensional Framework (4D)** structures the wider design context through attention to the learner, pedagogy, representation, and context (de Freitas & Oliver, 2006). **The Learning Mechanics–Game Mechanics model (LM–GM)** helps connect learning intentions to implementable game mechanics (Arnab et al., 2015). **Persuasive Systems Design** focuses on how system features can influence attitudes and behaviors (Oinas-Kukkonen & Harjuma, 2009). The central problem is that these models are complementary but need to be aligned in order to be used effectively.

This issue is of importance in the case of library gamification because design mistakes can intensify the barriers the game is intended to reduce. A system that can lead to feelings of public failure, features harsh evaluation, excessive time pressure or competitiveness may increase avoidance instead of confidence and participation. In this domain, alignment is not merely a matter of documentation; it is a condition of effectiveness and ethical acceptability (Walsh, 2014; Reed & Miller, 2020).

The present article builds directly on the earlier formulation of the Hybrid Educational-Persuasive Framework (Kratchanov, 2025). The previous publication established the need for a hybrid approach to library-oriented serious games by arguing that library anxiety requires the combination of cognitive, procedural, and affective outcomes, and that no single existing serious-game framework sufficiently covers this combined educational and persuasive task. The present study extends that earlier work in two directions. First, it shifts the focus from the general formulation of the hybrid framework to the alignment problem that emerges when frameworks operating at different levels of abstraction are combined. Second, it develops concrete alignment patterns and proposes an evaluation logic through which the conceptual framework can be transformed into testable design propositions.

2 What the Three Frameworks Contribute

The 4D framework is most useful at the macro level because it obliges designers to direct their attention to institutional context, learner characteristics, representational choices, and pedagogy (de Freitas & Oliver, 2006). The 4D framework consists of four dimensions: Context, Learner, Representation and Pedagogy. In a library SG, Context includes the particularities of the institution: spatial layout, behavioral norms, service rules, staff, and practical constraints. The Learner dimension is important because likely

users vary widely in age, prior experience, confidence, and frequency of use. For anxiety-sensitive design, the most relevant audience is often the first-time or irregular user who may be capable of using the library but feels unsure, judged, or unwelcome. The Representation dimension concerns the way the learner and the library's environment, personnel, services, and heritage materials are incorporated into the game world and how they are represented through virtual simulation or narrative. The Pedagogy dimension provides for the selection of an appropriate theoretical framework. An example of such framework, appropriate in the case of library gamification, is Self-Determination Theory (SDT). It is primarily a psychological theory of human motivation, personality development, and well-being. At the same time, SDT is highly influential in education because it explains how autonomy, competence, and relatedness shape engagement, internalization, and learning quality in educational settings (Deci et al., 1991). For that reason, it is often used as a theoretical foundation for pedagogical design and educational research, even though its origin is in motivational psychology. It argues that the motivation to accomplish a certain action depends on supporting autonomy, competence, and relatedness (Ryan & Deci, 2000). In a library serious game, those needs may translate into voluntary exploration (autonomy), growing mastery without pressure (competence), and a sense of belonging within the institution (relatedness). Many common gamification devices such as strict timers and penalties, leaderboards, and resource scarcity may create pressure that undermines autonomy and intensifies anxiety. By contrast, anxiety-sensitive design favors generous feedback, low-stakes repetition, optional help, and gradual exposure to more complex tasks (Proulx et al., 2017). The game should function less as a test and more as a simulator of participation: the player observes, rehearses, tries actions safely, and only later encounters more demanding or procedurally complex situations. Even when situative learning is primary, it can be supported by constructivist scaffolding and task-centered micro-instruction. Vygotskian scaffolding supports the notion for progressively fading support as confidence increases, together with Gagné's procedural emphasis on discrete routines, which in the case of libraries could be the procedure for catalogue searching or the steps necessary to borrow books (Vygotsky, 1978; Gagné, 1965).

The limitation of 4D is that it does not specify how the pedagogical choices become concrete game mechanics. That translational role can be served by the **LM-GM model**. This model distinguishes **learning mechanics** such as rehearsal, reflection, experimentation, or feedback from **game mechanics** such as quests, levels, progression systems, selection, or resource use (Arnab et al., 2015). Its value lies in making educational intent traceable at the level of gameplay and is particularly useful for procedural and situational learning because it forces designers to justify how a given mechanic is expected to produce a mode of learning (Fig.1).

Yet LM-GM does not by itself ensure that the resulting gamified experience will have attitude change and anxiety reduction as outcomes. A mechanic that supports rehearsal may still become stressful if it is punitive, competitive, or overly restrictive. The employment of PSD can address that missing dimension by focusing on attitude and behavior change (Fogg, 1998; Oinas-Kukkonen & Harjumaa, 2009). In the library context this is relevant because, as mentioned, the desired outcome is not only

knowledge acquisition, but also motivation and greater willingness to engage with the institution.

For the analysis of persuasion-related tasks, **Persuasive Systems Design (PSD)** distinguishes three principal areas of focus: *intent*, which denotes the source and objective of persuasion; *event*, which refers to the context in which the persuasive act takes place, including the user, the technology, and the situation of use; and *strategy*, which designates the methods by which influence is exerted on attitudes or behavior.

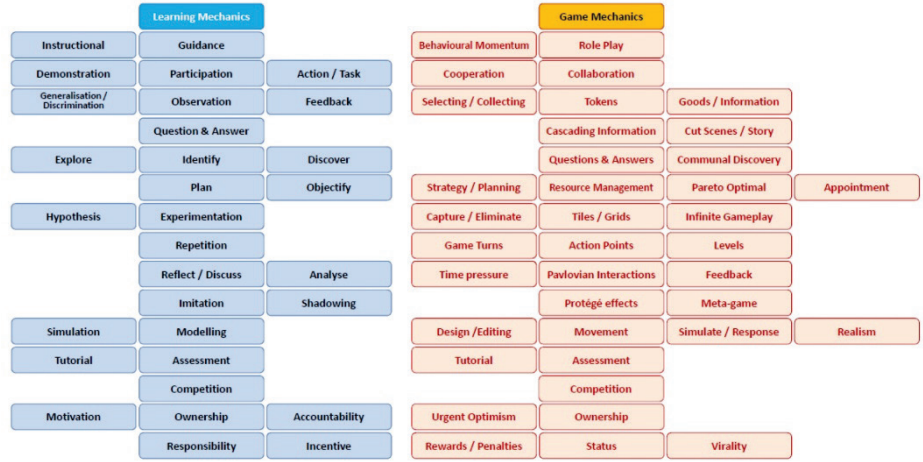


Fig. 1. LM–GM model: correspondence between learning mechanics and game mechanics (Arnab et al., 2015).

In order to implement PSD as gameplay features, the persuasive design principles are translated into concrete system features. The framework (Table 1.) proposed by Oinas-Kukkonen & Harjumaa (2008) organizes 28 principles into four groups: primary task support, dialogue support, system credibility support, and social support. Persuasive qualities are treated mainly as system qualities related to content and functionality, with examples showing how abstract principles ability, motivation, trustworthiness, or social comparison can become specific requirements and features (Oinas-Kukkonen & Harjumaa, 2008).

Table 1. PSD system features (Oinas-Kukkonen & Harjumaa, 2008).

Primary task support	Dialogue support	System credibility support	Social support
Reduction	Praise	Trustworthiness	Social learning
Tunneling	Rewards	Expertise	Social comparison
Tailoring	Reminders	Surface credibility	Normative influence
Personalization	Suggestion	Real-world feel	Social facilitation
Self-monitoring	Similarity	Authority	Cooperation
Simulation	Liking	Third-party endorsements	Competition
Rehearsal	Social role	Verifiability	Recognition

dimension of the 4D Framework so that pedagogical intentions could be translated into concrete gameplay choices in a more precise and actionable manner (Kratchanov, 2025).

3 The Central Alignment Issues and Ethical Dimension

The main issues in combining 4D, LM–GM, and PSD is that each uses a different, sometimes overlapping concepts and granularity of design. 4D frames the intervention as a whole educational experience, LM–GM works at the level of mechanics and interaction patterns, PSD moves between process-level analysis and reusable persuasive features. When these models are combined without a clear hierarchy, several problems appear. Designers may unintentionally duplicate the same idea in different vocabulary, leave gaps between goals and implementation, or create conflicts in which one layer undermines another. For example, a game may be pedagogically designed to encourage exploratory learning, while its persuasive layer pushes the player through a rigid sequence optimized for compliance. A quest may simultaneously function as a learning scaffold, a gameplay structure, and a persuasive tool, but unless those roles are separated conceptually, traceability becomes blurred and design decisions drift toward what is easiest to implement rather than what best serves the intervention’s aims.

A second alignment problem arises between SDT (if used as a support for 4D’s Pedagogy dimension) and PSD. SDT emphasizes volition and perceived choice, whereas PSD often recommends reduction and tunneling to lower friction and increase task completion (Ryan & Deci, 2000; Oinas-Kukkonen & Harjumaa, 2009). In an anxiety-sensitive environment, those strategies can help, but they can also be experienced as controlling. The solution is not to reject them, but to redesign them as autonomy-supportive scaffolds rather than hard constraints. Guidance should be optional, reversible, and explained respectfully. Players should be able to skip hints, choose mission order, and decide when to seek help. As competence grows, the system should gradually remove supports. Under those conditions, reduction and tunneling become aids to mastery rather than instruments of control, preserving autonomy while lowering the emotional cost of action (Reeve, 2006; Proulx et al., 2017).

In practical design work, this integration benefits from recurring *alignment patterns* tied to typical library anxieties. Spatial intimidation can be addressed through gradual map disclosure, low-stakes navigation tasks, optional route guidance, and affirming feedback. Fear of approaching staff can be addressed through observation, role-play, and branching dialogues with friendly non-punitive outcomes. Procedural uncertainty about borrowing, catalogues, or special collections can be addressed through demonstration, repeatable simulation, and progress tracking. Heritage engagement can be promoted by treating manuscripts, newspapers, maps, and rare books as primary interactive content rather than decorative background. In that case, the goal is not memorization, but curiosity, interpretation, and confidence in exploring textual heritage through credible context, narrative framing, and optional collaborative discovery (Mortara et al., 2014).

An important issue is the ethical dimension of PSD, which Fogg recognizes and devotes much attention to (Fogg, 2003). Libraries are public institutions whose authority depends heavily on trust. Persuasive tools that are potentially opaque and manipulative (such as surveillance and conditioning) are especially problematic in such environments. Scholarship on persuasive games and game ethics makes clear that interactive systems can shape beliefs and behaviors, but that designers remain responsible for how that influence is exercised (Bogost, 2007; Sicart, 2009). In the library domain, this means that social comparison should not stigmatize inexperienced users, credibility cues should not become patronizing, and heritage content should not be trivialized into mere rewards. The institution should also not be idealized, as problems certainly exist. If a game presents the library interaction as frictionless, while real users later face unexpected issues, the credibility of both the game and the institution may suffer. Ethical persuasive design therefore requires transparency, realism, and support rather than manipulation (Berdichevsky & Neuenschwander, 1999; Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2009).

4 Alignment Patterns for Reducing Library Anxiety and Encouraging Engagement with Heritage

To demonstrate how the models may work together, four examples of recurring sources of library anxiety can be paired with corresponding multi-model alignment patterns.

Pattern A: Spatial intimidation and uncertainty in orientation

- 4D: The Context dimension addresses the challenge of an unfamiliar physical environment, while the Pedagogical dimension stresses the gradual introduction of the space's layout and functions.
- LM: Guidance, Explore, Identify, Action/Task, Repetition, Feedback.
- GM: Levels (rooms/zones and optional navigation missions), Movement, Tiles/Grids, Goods/Information, Selecting/Collecting, Feedback.
- PSD: Tunneling, reduction (limiting early decision overload), and praise (reinforcing progress).

Design caution: In line with SDT, player autonomy should be preserved; public failure and strict time pressure should be avoided because they may heighten anxiety (Carlie, 2007).

Pattern B: Anxiety about interacting with staff

- 4D: The Learner dimension reflects social unease and fear of negative judgment, while the Representation dimension foregrounds approachable and supportive NPCs.
- LM: Modelling, Observation, Imitation, Question & Answer, Participation, Reflect/Discuss, Feedback.
- GM: Role Play, Questions & Answers (branching dialogue with non-punitive results), Collaboration (staff framed as helpers), Feedback, Cut Scenes/Story.

- PSD: Dialogue support (hints and prompts), credibility support (visible but respectful librarian expertise), and social support (positive examples).

Design caution: “Incorrect” questions should not be treated as failures; the design should protect user dignity and autonomy (Sicart, 2009).

Pattern C: Uncertainty about institutional procedures (catalog searching, borrowing, etc.)

- 4D: The pedagogical focus is on procedural competence, and the Representation dimension reflects authentic but properly simplified library workflows.
- LM: Tutorial, Demonstration, Simulation, Action/Task, Repetition, Assessment, Feedback, Plan.
- GM: Tutorial, Simulate/Response, Cascading Information (gradual information feed), Goods/Information (forms, regulations, catalog fields), Feedback, Levels (progressive complexity), Assessment.
- PSD: Self-monitoring (progress indicators), reminders, and tailoring (adaptive difficulty).

Design caution: Guidance should be balanced with freedom to explore so that the design does not become overly restrictive (SDT-PSD alignment) (Oinas-Kukkonen & Harjumaa, 2009).

Pattern D: Fostering interest in textual cultural heritage through curiosity, interpretation, and credible framing

- 4D: Heritage materials—such as newspapers, manuscripts, rare books, and maps—should function as the core interactive content rather than decorative background. Representation should balance authenticity with accessibility, while Pedagogy should prioritize inquiry and narrative interpretation over memorization, in ways suited to the library’s mission and audience (de Freitas & Oliver, 2006; Mortara et al., 2014).
- LM: Explore, Discover, Observation, Identify, Question & Answer, Analyse, Reflect/Discuss, Generalisation/Discrimination, Hypothesis, Experimentation, Feedback.
- GM: Selecting/Collecting (artifact-centered quests), Goods/Information (metadata), Levels (including possible mini-games), Cascading Information (layered contextual disclosure), Cut Scenes/Story (short narratives connected to objects), Communal Discovery (shared findings without pressure), Design/Editing (curating or assembling exhibits), Meta-game (collection journal), Realism (credible object representation), Feedback. Progression should reward curiosity and persistence rather than speed or pedagogical performance pressure (Mortara et al., 2014).
- PSD: Primary task support through reduction and tunneling to make first encounters with complex historical materials more approachable; dialogue support through praise and feedback that acknowledges effort (“good find,” “you linked two sources”); credibility support through provenance signals such as metadata, librarian or curator voice, and citations; and optional social support

through collaborative discovery features that encourage participation without competition (Oinas-Kukkonen & Harjumaa, 2009).

Design caution: Heritage should not be trivialized through excessive extrinsic rewards or by severing objects from their cultural meaning, as this may weaken perceived seriousness and diminish institutional credibility.

5 Evaluation: Making Alignment Testable

Any claim that 4D, LM-GM and PSD alignment reduces library anxiety should be viewed as a hypothesis and should be treated as a research question that requires empirical testing, rather than relying on it as a theoretical assumption. Testable hypotheses can be generated through a controlled experiment (a functional prototype) or a quasi-experimental study design.

The following three research questions can be used as the basis of the survey:

RQ1: Does a library-oriented serious game based on the Hybrid Educational-Persuasive Framework reduce self-reported library anxiety and is it more effective than conventional orientation methods? To identify the ways in which library anxiety is reduced, pre/post measures of anxiety may be used (based on Bostick's Library Anxiety Scale) to determine if there is measurable anxiety reduction (Mellon, 1986; Bostick, 1992; Carlile, 2007).

RQ2: Which combinations of pedagogical goals, learning mechanics, game mechanics, and persuasive features are perceived as supportive, and which may increase pressure and anxiety? Interviews and observations can help determine the outcome of specific features.

RQ3: Do users of the proposed serious game demonstrate better procedural competence in tasks such as wayfinding, catalogue use, and borrowing? Cognitive and procedural outcome measures can be evaluated using tasks that require users to locate an item and follow a borrowing procedure or navigate a service point. The overall design of the research will compare an experimental group that interacts with a serious game based upon the hybrid framework to a control group using traditional methods such as a guided tour or printed material. It may be useful to establish a third comparison group where an additional condition could be formulated by only using LM-GM, without using PSD for example, to assess the specific contribution of persuasive features. Designers will be able therefore to create testable propositions regarding whether guided tours support engagement or whether using dialogue to support the behaviours of interaction by library staff may increase the likelihood of the user's engagement with library staff.

The linking those hypotheses to concrete mechanics is contributed through the use of LM-GM; the 4D framework ensures that the interpretations are grounded in pedagogy, user characteristics and the institutional context; while PSD's structure will allow for an analysis of how the characteristics of systems (e.g., games) impact user's attitudes and behaviors. Using constructs from Self-Determination Theory (Ryan & Deci, 2000), we can assess the motivational outcomes of the games by measuring the users' perceptions of autonomy, competence and relatedness, the extent to which they were

engaged while interacting with the systems, and the perceived usefulness of the systems. We also believe that through qualitative methods (e.g., via interviews or think-aloud protocols), and considering the evidence that certain mechanics of games have been shown to lead to learners experiencing anxiety in stressful situations (Proulx et al., 2017), we will be able to identify those mechanics and persuasive features that are perceived by learners to be supportive of their learning, and those that may cause them to feel anxious. Creating an evaluation design plan for this work will set the stage for systematic/persistent testing and provide a basis for the future empirical validation of the proposed alignment.

6 Discussion: Limitations, Risks and Alternatives

The proposed hybrid framework is primarily conceptual and, as such, it will require empirical validation. According to research on gamification, the learning outcomes achieved through gamification are influenced by contextual factors and therefore cannot be consistently replicated (Deterding et al., 2011; Hamari et al., 2014). Furthermore, integrating multiple frameworks adds another level of complexity to the overall gamification design and can therefore create additional difficulties in its implementation.

An important risk that exists is the unintended consequences of using gamification. For example, adding elements like competition, time constraints, or penalties may hinder a novice's intrinsic motivation and/or increase their stress levels (Hanus & Fox, 2015). The effects of creating library anxiety support the use of persuasive techniques in a manner that is congruent with the principles of autonomy support as based on Self-Determination Theory (Ryan & Deci, 2000).

There are also ethical considerations that must be taken into account. Persuasive technology can impact a user's attitudes and behaviours (Fogg, 2003) and therefore concerns arise about the transparency of their use and the user's autonomy. This is particularly relevant to libraries concerning how persuasive technologies should be used to facilitate informed participation, rather than user manipulation (Berdichevsky & Neuenschwander, 1999).

There are also alternate approaches to orienting library users to the library. For example, libraries have traditionally employed guided tours and instructional materials, however, more recently have begun to incorporate alternative types of mediated experiences such as virtual or augmented reality environments (Hahn, 2012). Although serious games can provide high levels of interactivity and experiential learning, they typically require more resources to implement and may not be the most resource-efficient way to meet the needs of library users.

There is also a risk of trivializing cultural heritage content when creating games with no consideration for context. Ian Bogost (2007) points out that procedural representations can communicate meaning; however, if the system is poorly designed, it may create a simplistic representation of a complex body of material. In order to avoid this issue, it is important to use strong contextual framing and a focus on interpretive engagement (Mortara, et al., 2014).

While the above issues are legitimate concerns, the proposed patterns for reducing library anxiety and encouraging engagement with heritage provide a structure for aligning educational, motivational and persuasive designs and thus will provide a coherent foundation upon which to support empirical analysis and practical application in a variety of library contexts upon which future research and studies will be based.

7 Conclusions

The appeal of combining 4D, LM–GM, and PSD lies in the premise of an SG design process that is simultaneously educationally grounded, mechanically actionable, and behaviorally purposeful. Yet this promise is realized when alignment is treated as a design method in its own right. In the library domain, this is important because success depends not only on learning outcomes, but also on emotional safety, motivation and trust in the institution.

For library-oriented SGs, the most productive approach is therefore a layered one: 4D defines the overall framework, LM–GM operationalizes learning into play, and PSD shapes support for motivation, confidence and action. Combined with explicit traceability and careful evaluation, this arrangement makes it more likely that the resulting game will not simply transmit information but help users enter the library as capable participants and engage more deeply with its textual cultural heritage.

The original contribution of this study lies in its domain-specific alignment logic for library-oriented serious games and introduces the idea of anxiety-sensitive alignment, meaning that mechanics and persuasive features are assessed not only by their educational function, but also by their possible emotional impact on inexperienced or hesitant library users.

The paper further distinguishes between the theoretical core of the hybrid model and its applied design patterns. The core model defines how educational, ludic, and persuasive layers should be connected, while Patterns A–D illustrate this connection in typical library-anxiety situations. By linking these patterns to measurable variables and testable indicators, the study contributes a traceability-oriented approach for moving from conceptual design toward prototype development and empirical validation.

Although the proposed design principles were developed in the context of library gamification, their underlying logic is not limited to this domain. Because they support the systematic alignment of educational, motivational, and persuasive design goals, they may also be adapted for use in other fields such as policy-making, including environmental awareness, sustainability, and other forms of civic engagement, education, and healthcare.

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