

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/394757806>

The Spectrum of Abstraction and Realism in Serious Games for Learning

Preprint · August 2025

DOI: 10.13140/RG.2.2.27301.41440

CITATIONS

0

READS

90

3 authors:



[Kristina Risley](#)

University of Southampton

6 PUBLICATIONS 6 CITATIONS

[SEE PROFILE](#)



[Zoltán Buzády](#)

Corvinus University of Budapest

57 PUBLICATIONS 618 CITATIONS

[SEE PROFILE](#)



[Liang Xu](#)

Dublin City University

22 PUBLICATIONS 58 CITATIONS

[SEE PROFILE](#)

The Spectrum of Abstraction and Realism in Serious Games for Learning

Kristina Risley¹, Zoltan Buzady², Liang Xu³

¹University of Southampton, Southampton, UK

²Corvinus University of Budapest, Hungary

³Dublin City University, Dublin, Ireland

k.risley@soton.ac.uk

zoltan@buzady.hu

liang.xu@dcu.ie

Abstract: The design of serious games for learning is shaped by a fundamental tension between realism and abstraction. Realism in serious games can manifest in multiple dimensions, such as graphical fidelity, sound design, game mechanics, narrative structure etc. Some serious games aim for high-fidelity simulation, replicating real-world scenarios as closely as possible (e.g., flight simulators or medical training applications). Others may incorporate abstract elements while still being grounded in real-world principles, such as strategy games that simplify complex decision-making processes. Abstraction, by removing unnecessary complexity, may reduce extraneous cognitive load and enhance generalisation of learning. In contrast, realism may support situated learning and contextual skill transfer, particularly when training requires familiarity with real-world environments. To better understand the implications of abstraction and realism in serious game design, this paper comparatively explores two case studies: FLIGBY, a corporate leadership development game CIPHER, a language-learning game designed for children. Findings identify six key dimensions that differentiate abstraction and realism in serious games: visual style, audio style, mechanics and interface, rule systems and feedback. Engagement, motivation and cultural perception are also considered, noting that realism may appeal more in professional settings, while abstraction may be particularly effective in child-centred learning environments. This research contributes to the broader field of serious games by providing a conceptual framework to guide educators, game designers and researchers in making informed design decisions, also offering a foundation for future empirical research.

Keywords: Serious Games, Abstraction vs. Realism, Learning Transfer, Game Design

1. Introduction and Problem Statement

Serious games operate within a complex design space where developers must balance abstraction and realism to effectively achieve the desired cognitive, behavioural and affective outcomes. As Adams, (2014) notes, all game design involves a degree of abstraction, whether through simplification of mechanics, stylisation of visuals or metaphorical representations of complex systems. When designing for learning however, the implications of such abstractions must be carefully considered in terms of what they emphasise, obscure or distort and how they serve the pedagogical goals. Realism is commonly associated with high-fidelity simulations, aiming to mirror real-world environments and procedures for situated cognition and skill transfer (Risley & Wanick, 2025). In contrast, abstraction often distils core elements of experiences, intentionally stripping away other surface-level complexity to focus attention, reduce cognitive load and potentially improve generalisation across learning contexts (Bai et al., 2023; Ravyse et al., 2017; Xu et al., 2024). This has also been found in some cases to lead to higher levels of enjoyment and engagement, therefore motivation when compared to a more realistic counterpart (Lee et al., 2020).

The pedagogical benefits and trade-offs of these approaches have been explored in prior work, but definitions of abstraction and realism often remain imprecise, particularly across different game elements. Existing research has typically addressed isolated dimensions of fidelity such as visual realism (Bai et al., 2023; Hameed et al., 2021), narrative structure (Naul & Liu, 2020), or interaction mechanics (Ye et al., 2020), but few studies have synthesised these into a cohesive framework to support holistic design decisions. Moreover, studies often focus on one end of the spectrum or conflate realism with quality, ignoring how abstraction can be equally deliberate and pedagogically effective. For example, fantasy-based learning games have been shown to enhance motivation and conceptual understanding when abstraction is closely aligned with learning goals (Naul & Liu, 2020; Papastergiou, 2009; Xu et al., 2024). However, realistic representations, particularly in the form of high-fidelity visuals, believable soundscapes or authentic scenarios can enhance credibility and the perceived ‘seriousness’ of a game (Risley & Wanick, 2025). This is especially relevant in domains such as business, medicine and aviation where simulation-style fidelity is typically expected to mirror real-world

training needs and underpins assurances of professional competence (Abdulhussain et al., 2022; Fox & Uzuegbunam, 2018; Noble, 2002).

This presents a gap in literature and space for a structured framework that allows game designers to consider, analyse and balance these concepts in a systematic and pedagogically informed way. Realistic and abstracted approaches are each grounded in sound pedagogical reasoning, yet the literature reveals limited clarity in how the various elements of realism and abstraction are defined, assessed and ultimately operationalised across elements of game design. This work seeks to address that gap by proposing a conceptual framework comprising six key dimensions: visual style, audio, mechanics, rule systems, narrative and feedback - each considered along a spectrum of abstraction and realism.

2. Related Work: Theoretical Foundations

Play is increasingly recognised as a powerful mechanism beyond simple recreation through which individuals can learn, experiment and engage with structured systems of meaning. Huizinga's (1955) notion of the "magic circle" conceptualises play as a bounded, voluntary activity, distinct from ordinary life yet deeply meaningful within its own internally consistent logic. This separation can afford learners a protected space for exploration where risk is minimised, failure is instructive and boundaries are negotiable to a greater or lesser extent. Games further formalise this space through rule-bound structures (Salen and Zimmerman, 2004), creating what Adams (2014) terms "pretend realities" - representations that always involve some degree of simplification, stylisation or metaphor. These abstractions are therefore seen not as flaws but foundational design features; even games that appear realistic are inherently selective in terms of fidelity, choosing which elements of the real world to simulate and which to adjust. This selectivity appears to be central to the pedagogical strength of serious games. Realism, whether sensory, procedural or narrative can enhance immersion, credibility and learning transfer by anchoring learning in familiar contexts. Abstraction however enables playability, supports generalisation across scenarios and focuses attention on conceptual relationships, unhindered by additional cognitive demands (Westera et al., 2008). In the context of playful learning as a phenomenon mediated by some degree of abstraction it therefore stands to reason that realism and abstraction sit at either ends of a broad spectrum rather than being categorically binary concepts.

Realism and abstraction often function as overlapping design strategies that shape how serious games communicate meaning, structure interaction and guide learning. These qualities operate across multiple components such as visuals, narrative, mechanics etc and are rarely applied uniformly. Fernández-Vara (2011) proposes that realism is shaped by the alignment between a game's rules, the fictional world and the relevant simulation systems; where this alignment is strong, experiences tend to feel more coherent and believable. In serious games, this coherence is often regarded as supporting skill transfer or professional relevance, yet it may also limit the design space or reduce accessibility for novice learners. Conversely, abstraction can heighten clarity and reduce distraction, but may require players to exert more interpretive effort to understand how in-game actions relate to real-world contexts. Rather than resolving this through universal rules, designers must work across several dimensions. Furthermore, Ye et al. (2020) distinguish between objective fidelity: the extent to which in-game systems mirror real-world counterparts and subjective fidelity: how authentic and meaningful the game feels to its audience. Both can influence engagement and learning outcomes, but their value depends on the learner's prior knowledge, the purpose of the game and the complexity of the content. Further attempts to formalise these patterns are emerging in the work of authors such as Rogers et al. (2022), who present a taxonomy breaking realism into several discrete types across visuals, mechanics, sound, narrative and systems logic. While its granularity poses challenges for practical use, this work does illustrate how realism is constructed, rather than inherent, reinforcing the need for frameworks to assist designers making informed decisions across each design dimension.

The design of serious games must also take account of learners' cognitive capacities. Cognitive Load Theory (Sweller, 1988) highlights how unnecessary complexity can impose extraneous processing demands, which may hinder comprehension, particularly for learners with limited prior knowledge. Serious games that prioritise high-fidelity realism across visual or interactional elements may inadvertently burden learners with unnecessary additional information, reducing the cognitive resources available for the target task. Ravyse et al. (2017) extend this concern to game environments, noting that excessive detail or realism, especially when not directly aligned with the learning objective, can actually obscure rather than enhance instructional clarity. Abstraction, in contrast, can function as a pedagogical tool by focusing learners' attention toward core concepts. However, where learners are expected to navigate professional or domain-specific scenarios, greater

realism may be necessary to situate decisions in context and support transfer to authentic settings (Risley & Wanick, 2025). The effectiveness of realism therefore appears to lie in how deliberately it is aligned with learners' existing knowledge and the complexity of the task. At opposite ends of a spectrum, abstraction and realism function as strategic design choices, shaping how information is processed and supporting learner-centred progression.

The design of serious games inevitably raises the question of what kind of learning is intended to transfer beyond the game environment and under what conditions such transfer is most likely to occur. This aligns with research by Ye et al. (2020) who distinguish between physical fidelity (how environments are visually and spatially represented) and functional fidelity (how tasks and systems behave). Both contribute to the perceived authenticity of a simulation and may reinforce domain-specific routines - in many learning scenarios the objective is not replication but adaptation. Perkins and Salomon's (1992) distinction between near and far transfer draws attention to the value of abstraction in fostering generalisable understanding. Abstract representations, by stripping away surface features, can help learners focus on the deeper structure of a task or principle, making them more likely to apply this knowledge across novel or variable contexts. This is particularly relevant in domains such as ethics, communication or early-stage skill development, where fixed procedural knowledge may be less useful than conceptual flexibility. Naul and Liu (2019) further argue that narrative abstraction, including the use of metaphor or fantastical framing, can make complex or sensitive topics more accessible. In this sense, abstraction is not a compromise in fidelity but a deliberate strategy to support transfer across cognitive, emotional and cultural boundaries. For game designers, the goal is therefore to calibrate fidelity in line with the kind of learning transfer the game intends to support, rather than maximising fidelity. This requires a nuanced understanding of how different forms of abstraction and realism function within and across learning contexts.

Motivation and engagement are foundational to effective learning through games, with intrinsic motivation often linked to enjoyment, autonomy and mastery - shaped by how realism and abstraction are implemented in a game's design (Ryan & Deci, 2020). Lee et al. (2020) found in some contexts, abstracted designs led to greater enjoyment and engagement than their more realistic counterparts, particularly when stylisation enhanced playability or reduced cognitive friction. For younger learners, abstracted environments can be especially powerful in sustaining engagement with stylised visuals, simplified mechanics and imaginative metaphors supporting playful exploration and psychological safety, while enabling learners to focus on core concepts without distraction (Naul & Liu, 2020; Papastergiou, 2009). In contrast, learners in professional settings may be motivated by high-fidelity scenarios mirroring lived experiences. For instance, realistic feedback, authentic narrative and decision-making enhances the perceived seriousness and relevance of the learning task (Risley and Buzady, 2022). In these contexts, realism can be motivational as well as representational, reinforcing domain expectations and validating the learner's professional identity.

Finally, realism also raises ethical and cultural considerations, particularly in games addressing real-world events, identities or sensitive subject matter (Hormozi, 2025). McGonigal (2011) and Frasca (2003) argue that games are culturally situated artefacts which shape and are shaped by the narratives and values of the societies in which they circulate. In which case, abstraction offers somewhat of a pedagogical safeguard: a means of creating emotional distance, avoiding stereotyping and engaging players in critical reflection.

3. Framework Overview: Design Dimensions of Abstraction and Realism

Drawing on interdisciplinary sources from game studies, educational psychology and serious game design, a framework emerges composed of the following elements:

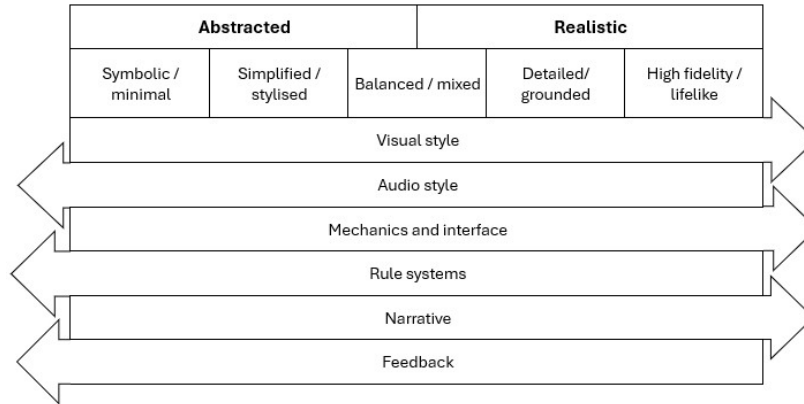


Figure 1: Design Dimensions Framework

3.1 Visual Style

Visual style is a key dimension through which abstraction and realism manifest in serious games. Realistic visual designs often incorporate photorealistic textures, anatomically correct models and adaptive lighting systems to replicate real-world environments. These are typically seen in simulation-based training tools such as medical procedure trainers or flight simulators, where visual accuracy supports domain-specific recognition and context-sensitive learning (Chalmers & Debattista, 2009). At the abstract end of the spectrum, games may rely on simple geometric shapes, colour-coded systems, or schematic representations to convey meaning. Language-learning games for children, for instance, often use cartoon-style avatars and simplified spatial layouts to reduce visual clutter and make core interactions more accessible (Bai et al., 2023). In these cases, abstraction supports cognitive economy, especially for novice users or when focusing on conceptual rather than spatial or procedural knowledge. Designers may also opt for stylised realism, which involves selectively enhancing or downplaying visual detail to support learning while maintaining user engagement (Ravyse et al., 2017).

3.2 Audio Style

Audio style contributes to immersion and instructional effectiveness, offering spatial, emotional and procedural cues that shape the player's interpretation of the game world. In realistic games, sound design might include ambient environmental noise, adaptive audio, or professional voice acting - all calibrated to mirror real-life acoustics and enhance situational awareness (Vontzalidis et al., 2024). This is particularly relevant in domains such as emergency response or clinical simulation, where auditory input is integral to task performance (Du et al., 2025; IEEE, 2025). High-fidelity audio can also support affective learning and well-integrated soundscapes have been found to enhance the emotional plausibility of scenarios, contributing to player engagement and memory consolidation (Ravyse et al., 2017). Marucci (2021) further argues that consistency between visual and auditory design supports internal coherence, reinforcing the learner's sense of presence within the simulated environment. At the abstract end of the spectrum, audio may consist of simplified cues such as chimes, buzzers and synthesised tones, or stylised music and effects. These can function effectively within symbolic or metaphorical game worlds, particularly when aligned with visual style and feedback systems. However, Bai et al. (2023) caution that even abstract sound design must remain consistent within the game's internal logic to avoid cognitive dissonance. For example, fantasy-based learning games may use non-representational soundscapes that, while lacking fidelity, remain perceptually congruent and maintain narrative engagement.

3.3 Mechanics and Interface

Game mechanics and interface design determine how learners interact with the game world. Realistic mechanics typically replicate real-world tasks or procedures, which might involve simulating the physical controls of a forklift, the steps of a surgical procedure, or the decision-making processes in a corporate setting, for example. In such contexts, learners engage with systems that mirror the complexity and sequencing of professional practice and high interaction fidelity, where user inputs closely match real-world actions can support skill transfer, particularly in procedural training domains (Ye et al., 2020). In contrast, abstracted

mechanics typically simplify these interactions: a complex process may reduce to a click or visual choice. For example, rather than manipulating detailed instruments in a surgical simulation, a game might use a drag-and-drop system or a multiple-choice format to represent clinical reasoning. Similarly, interfaces in abstracted games tend to use symbolic icons, menu-based navigation or colour-coded feedback, supporting usability and lowering cognitive demand (Ravyse et al., 2017). Balance is important: while realistic mechanics can support experiential learning, particularly for advanced learners or high-stakes environments (Chalmers & Debattista, 2009), overly complex mechanics may hinder accessibility and immersion, particularly for novice learners.

3.4 Rule Systems

Rule systems define the underlying logic of a game: how player actions trigger outcomes, how time and resources behave and how the environment responds in turn. More realistic rule systems replicate domain-specific logic with high fidelity, for example flight simulators often model aerodynamics, engine systems and procedural checklists to ensure that training outcomes transfer to real-world performance (Ye et al., 2020). These systems typically prioritise procedural and functional fidelity, reinforcing cause-effect relationships in line with the real-world phenomena they aim to simulate. At the other end of the spectrum, abstracted rule systems may strip back complexity to foreground educational themes or streamline play. For instance a time-intensive process may be represented as a turn-based sequence or compressed into a single decision point, such as a game on sustainability modelling resource management through simplified algorithms or metaphorical tokens rather than detailed environmental systems. These abstractions are often useful when the goal is conceptual understanding or values exploration, rather than procedural training (Ravyse et al., 2017). The credibility of the rule system ultimately depends on internal consistency and alignment with learner expectations and instructional goals. If rules appear arbitrary or inconsistent, they can undermine both immersion and learning outcomes, which has particular relevance in the behaviour of non-player characters (NPCs), whose responses must feel plausible even when simplified. Behavioural fidelity, as Ravyse et al. (2017) note, can anchor players' decision-making in realistic social dynamics even when underlying systems are partially abstracted.

3.5 Narrative Structure

Narrative is a powerful tool for anchoring meaning and whether presented through linear storylines or branching dialogue, narrative structures provide emotional context, scaffold decision-making and shape how learners interpret game events. At the realistic end of the spectrum, narratives draw directly from real-world settings, which may involve authentic professional dilemmas such as resolving conflict in a workplace, managing patient care, or making ethical business decisions. Realistic narrative design can enhance the relevance of educational content by embedding it in plausible social and institutional contexts (Xenos & Velli, 2020). When characters, settings and challenges reflect learners' lived or aspirational experiences, narrative is a powerful vehicle for situated learning, supporting the transfer of behaviours and attitudes into real-world practice. Abstract or metaphorical narratives instead prioritise more symbolic representations over strict realism, which might include allegorical journeys, cryptic quests or stylised metaphors for internal processes, such as battling diseases represented as defeating monsters. In educational games targeting conceptual understanding or personal growth, such abstractions can be highly effective; metaphorical framing can enhance emotional engagement and make abstract ideas more approachable - particularly in language learning or identity-based scenarios (Naul & Liu, 2020; Xu et al., 2024).

3.6 Feedback Systems

Feedback in serious games plays a central role in shaping learner behaviour, supporting reflection and sustaining engagement, informing players whether their actions are effective and helping them understand the consequences of their decisions. The degree of realism embedded in these feedback mechanisms can influence how learning is experienced and internalised (Mozdzer, 2021). More realistic feedback is largely embedded within the game world as a direct, contextually meaningful response. For example, in a medical simulation like *Body Interact* (Take the Wind, 2025), failing to administer treatment may result in a virtual patient's condition deteriorating. This form of diegetic feedback mirrors real-world cause and effect, reinforcing understanding through experiential learning (Marshall, & Honey, 2023). When aligned with authentic scenarios, realistic feedback supports situated cognition, helping learners understand not just what went wrong, but why. In comparison, abstract feedback systems often use external or symbolic cues to guide performance such as

points, stars, badges or progress bars. These indicators can enhance transparency and motivation by making goals and achievements explicit, particularly in fast-paced or conceptual learning environments. Ravyse et al. (2017) argue that abstracted feedback can be effective when used to highlight core behaviours or scaffold understanding, provided it does not distort the underlying learning logic. In reality, effective serious games often adopt a hybrid approach. In-game consequences provide immediate, immersive feedback, while post-level summaries or visual dashboards allow for debrief and reflection.

4. Case Studies

4.1 Case Study One: FLIGBY

FLIGBY (Risley and Buzady, 2022) is a leadership training simulation designed for adult learners in corporate or professional education settings. FLIGBY's visual appearance blends stylised cartoon animation with interwoven use of realistic video elements filmed with live actors to produce a fluid, semi-realistic aesthetic (Figure 2). The hybrid visual style supports narrative congruence and distinguishes reflective moments from interactive sequences. Audio design is minimal and realistic, featuring ambient office sounds and selective voice acting that ground the experience in a plausible work environment. Dialogue is primarily text-based, with voiceovers used to signal key moments or reinforce tone.

Mechanically, FLIGBY employs simplified point-and-click interactions focused on managerial decision-making. Players select from response options during dialogue, shaping how virtual team members respond across the simulation. Rule systems track multiple internal variables based on these decisions such as profit, sustainability and employee wellbeing - linking player choices to cumulative scenario outcomes.

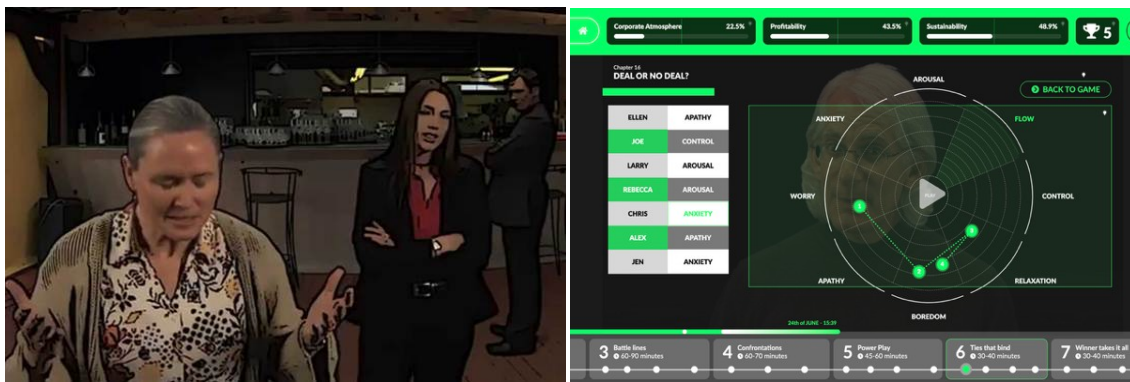


Figure 2: FLIGBY Stylised Narrative Scene and Gameplay Dashboard Screenshots

Narratively, the game unfolds through a linear scenario in which the player acts as general manager of a winery. Events are grounded in realistic workplace challenges, including conflict resolution, performance coaching and ethical decision-making. Feedback is delivered primarily through in-game consequences and post-scenario debriefs with an in-game mentor. Overall, FLIGBY's design reflects a realism-oriented approach, intended to simulate professional judgement in a contextualised, low-risk environment.

4.2 Case Study Two: Cipher

Cipher (Xu et al., 2024) is a serious game designed for learning Irish, through a relatively abstracted style. Visually, Cipher employs minimalist, cartoon-like, low-poly graphics, intentionally distancing itself from realism to reduce cognitive load and foster engagement without overwhelming learners (in this case, school children). AI-generated images are stylised further to maintain narrative consistency and avoid the uncanny valley effect (Figure 3). Its audio design mirrors this abstraction, featuring synthetic, dramatic voiceovers and sound effects that enhance the fantastical theme rather than aiming for naturalistic representation.



Figure 3: CIPHER Gameplay Screenshots

Mechanically, interaction is simplified, relying on basic, intuitive controls that prioritise ease of access over realistic simulation. The interface is deliberately rudimentary, ensuring that learners focus on core language tasks (vocabulary, reading, writing, etc.) rather than complex navigational skills. Rule systems are metaphorical, involving gamified features such as ‘spirit power’ (points) and ‘magical eyes’ (power-ups), streamlining cause-effect relationships while maintaining motivational structures.

Narratively, CIPHER draws on Irish folklore fused with imaginative elements, creating a symbolic storyline where players must lift spells corrupting ancient tales. Feedback is gamified and abstract, supporting flow and sustained engagement. Overall, CIPHER leans toward the abstract end of the spectrum, exemplifying a design strategy that supports conceptual learning, engagement, and cultural immersion for young language learners.

5. Discussion

This work proposes a structured framework for examining how realism and abstraction are operationalised across six design dimensions in serious games. Drawing on established learning theory and design research, it is argued that these concepts are best understood as design strategies, calibrated in relation to audience needs, learning goals and contextual expectations. The case studies of CIPHER and FLIGBY show how different choices along this spectrum can serve distinct pedagogical functions. In CIPHER, abstraction supports clarity, imaginative engagement and accessibility for younger learners. Stylised visuals, metaphorical mechanics and simplified feedback structures help maintain focus on core language tasks. These choices reflect an emphasis on generalisation over specificity and are consistent with evidence that abstraction can reduce cognitive load while supporting motivation and learning flexibility (Ravyse et al., 2017; Naul & Liu, 2020; Lee et al., 2020). In contrast, FLIGBY uses a more typically realistic design to reflect professional leadership challenges. Decision-making mechanics mirror workplace dilemmas and performance consequences are integrated across a longer timeline. This form of functional fidelity is designed to enhance authenticity and support transfer to real-world contexts (Ye et al., 2020; Squire, 2011). The game’s hybrid visual style maintains accessibility while reinforcing the credibility of the scenario. In both cases, abstraction and realism are selectively applied across dimensions, rather than applied universally to the game. This reflects the core principle that fidelity should be matched to the pedagogical function of each design component.

A detailed matrix is included in Appendix 1, intended to provide a prototype tool for assessing serious games against the six design elements presented in the framework. Each dimension contains 5 contextual points describing the degree of abstraction or realism for designers to assess how these present in their games.

6. Conclusion, Limitations and Future Work

The proposed matrix serves as an initial framework but requires further refinement; its currently broad descriptors would benefit from greater specificity to better support design decisions. As research studying abstraction and realism across multiple game elements remains limited, future work will focus on empirical validation, including testing with game players, serious game designers and researchers. Iterative revisions based on structured feedback will help improve its clarity and applicability. Expanding the matrix to accommodate diverse educational contexts and cultural perceptions of realism and abstraction is also further a direction for future research.

Ethics declaration

This research did not involve human participants, personal data or any procedures requiring formal ethical approval.

AI declaration

The authors made very limited use of generative AI to explore alternative phrasings and check consistency in terminology. All intellectual contributions and analytical decisions were made by the authors.

References

- Abdulhussain, Y., Ghelani, H., Henderson, H., Sudhir, M., Mascarenhas, S., Radhakrishnan, R., & Jan, R. K. (2022). The use and effectiveness of high-fidelity simulation in health professions education: current update. *Simulation*, 98(12), 1085-1095.
- Adams, E. (2014). *Fundamentals of Game Design*. New Riders Publishing.
- Bai, H., Berg Marklund, B., & Wilhelmsson, U. (2023). A Model for Balancing Clarity and Appeal in Serious Game Visuals. In T. Spil, G. Bruinsma, & L. Collou (Eds.), *Proceedings of the 17th European Conference on Games Based Learning*.
- Chalmers, A., & Debattista, K. (2009). Level of realism for serious games. *Proceedings of the 2009 Conference in Games and Virtual Worlds for Serious Applications, VS-GAMES 2009*, 225–232.
- Du, D., Oh, J., Lau, N., Parker, S., Upthegrove, T., Price, J., Baber, A., & Jones, N. (2025). Unlocking the Tesseract: Exploring Immersive Auditory Environments in Clinical Simulation. *HFEA International Symposium on Human Factors and Ergonomics in Health Care*.
- Fernández-Vara, C. (2011). *Introduction to Game Analysis*. Routledge.
- Frasca, G. (2003). Simulation versus Narrative: Introduction to Ludology. In M. J. P. Wolf & B. Perron (Eds.), *The Video Game Theory Reader*. Routledge.
- Fox, J., Pittaway, L., & Uzuegbunam, I. (2018). Simulations in entrepreneurship education: Serious games and learning through play. *Entrepreneurship Education and Pedagogy*, 1(1), 61-89.
- Hameed, A., Perkis, A., & Moller, S. (2021). Evaluating hand-tracking interaction for performing motor-tasks in VR learning environments. *2021 13th International Conference on Quality of Multimedia Experience, QoMEX 2021*, 219–224.
- Hormozi, Y. (2025). Introducing the CultureCraft Model (CCM): A Creative Process Framework for Cultural Adaptation in Game design. *2025 Digital Games Research Association (DiGRA) Ireland Inaugural conference*.
- Huizinga, J. (1955). *Homo Ludens: A Study of the Play Element in Culture*. Beacon Press.
- IEEE (2025). *Virtual Reality Training: Preparing First Responders for High-Risk Scenarios Safely and Effectively*. IEEE Public Safety Technology Initiative.
- Lee, L., Gee, S., & Dolah, J. (2020). Abstract or Realistic Style: Inclusive Designing for Student Experience in Educational Games. *ASM Science Journal*, 13(3), 82–88.
- Marshall, D., & Honey, M. (2023). The Impact of a Simulation-Based Learning Activity Using Actor Patients on Final Year Nursing Students' Learning. *Nursing Praxis in Aotearoa New Zealand*, 39(2).
- Marucci, M., Di Flumeri, G., Borghini, G., Sciaraffa, N., Scandola, M., Pavone, E. F., ... & Aricò, P. (2021). The impact of multisensory integration and perceptual load in virtual reality settings on performance, workload and presence. *Scientific Reports*, 11(1), 4831.
- Mozdzer, M. A State of the Art on Feedback in Serious Games. [Master's thesis, University of Geneva].
- McGonigal, J. (2011). *Reality Is Broken*. THE PENGUIN PRESS.
- Naul, E., & Liu, M. (2020). Why Story Matters: A Review of Narrative in Serious Games. *Journal of Educational Computing Research*, 58(3), 687–707.
- Noble, C. (2002). The relationship between fidelity and learning in aviation training and assessment. *Journal of Air Transportation World Wide*, 7(ISSN: 1093-8826).
- Papastergiou, M. (2009). Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation. *Computers and Education*, 52(1), 1–12.
- Perkins, D., & Salomon, G. (1992). Transfer Of Learning. In T. N. Postlethwaite & T. Husen (Eds.), *International Encyclopedia of Education*, (2nd ed). Pergamon Press.
- Petridis, P., Dunwell, I., Panzoli, D., Arnab, S., Protosaltis, A., Hendrix, M., & de Freitas, S. (2012). Game Engines Selection Framework for High-Fidelity Serious Applications. *International Journal of Interactive Worlds*, 1–19.
- Ravyse, W. S., Seugnet Blignaut, A., Leendertz, V., & Woolner, A. (2017). Success factors for serious games to enhance learning: a systematic review. *Virtual Reality*, 21(1), 31–58.
- Risley, K., & Buzady, Z. (2022). FLIGBY: The Serious Game Harnessing Flow Experience for Leadership Development. In *International Conference on Games and Learning Alliance* (pp. 53-62). Cham: Springer International Publishing.
- Risley, K., & Wanick, V. (2025). Asking the Experts: A Delphi Method Investigation into Serious Games for Leadership Development. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 15348 LNCS, 233–242.
- Rogers, K., Karaosmanoglu, S., Altmeyer, M., Suarez, A., & Nacke, L. (2022). Much Realistic, Such Wow! A Systematic Literature Review of Realism in Digital Games.
- Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, 61.
- Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. In *COGNITIVE SCIENCE* (Vol. 12).
- Take The Wind, S.A. (2025). *Body Interact* [Mobile application software]. Google Play.
- Vontzalidis, G., Mystakidis, S., Christopoulos, A., & Moustakas, K. (2024, June). Spatial Audio Cues in an Immersive Virtual Reality STEM Escape Room Game: A Comparative Study. In *International Conference on Immersive Learning* (pp. 317-328). Cham: Springer Nature Switzerland.

- Westera, W., Nadolski, R. J., Hummel, H. G., & Wopereis, I. G. (2008). Serious games for higher education: a framework for reducing design complexity. *Journal of Computer Assisted Learning*, 24(5), 420-432.
- Xenos, M., & Velli, V. (2020). A serious game for introducing software engineering ethics to university students. In *The Challenges of the Digital Transformation in Education: Proceedings of the 21st International Conference on Interactive Collaborative Learning (ICL2018)-Volume 1* (pp. 579-588). Springer International Publishing.
- Xu, L., Thomson, J., Dhonnchadha, E. U., & Ward, M. (2024). Learner-Oriented Game Design: The Evolution of Cipher. 2024 IEEE Gaming, Entertainment, and Media Conference, GEM 2024.
- Ye, X., Backlund, P., Ding, J., & Ning, H. (2020). Fidelity in Simulation-Based Serious Games. *IEEE Transactions on Learning Technologies*, 13(2), 340–353.

Appendix A - Matrix of Design Dimensions in Abstraction and Realism

	Abstract <-----> Realistic				
Dimension	Symbolic / minimal	Simplified / stylised	Balanced / mixed	Detailed/ grounded	High fidelity / lifelike
Visual style	Icons / symbols / flat shapes with minimal detail / text only	2D or cartoon style, blurry / simplified anatomy or environment	Recognisable forms with selective realism in environments, characters etc	3D environments with natural scale and features , with selective stylisation	Photorealistic textures or environmental detail, anatomical accuracy
Audio style	No sound or basic tones (e.g. beeps, chimes), unrelated to game context	Stylised effects, limited audio cues, repetitive loops	Mix of sound effects and selective speech or ambient cues	Layered soundscapes with ambient details, some voice acting	Rich, dynamic spatial audio, nuanced effects, full voice acting
Mechanics and interface	Simple and not directly representational (e.g. click through menus / choices)	Basic controls (e.g. taps / clicks), functionally suggestive, low procedural detail	Reflective of real-world workflows, largely reduced complexity	Actions and interfaces mimic real-world procedures, tools or workflows	Realistic two-way input methods, precisely emulated actions / controls
Rule systems	Arbitrary rules, simplified logic (e.g. collecting coins), unrelated cause-effect	Simplified systems with basic logic & cause-effect, metaphors progress	Logic partly reflects real world cause-effect, without full complexity	Cause-effect reflects domain-relevant logic, modelled on real trade-offs	Closely models real-world dynamics, complex / linked outcomes
Narrative	Minimal context, no cohesive storyline (e.g. play framed by instructions only)	Simplified or fantastical story elements (e.g. fantasy quests / vague missions)	Loosely mirrors real-world themes, with metaphorical or fictional narrative	Authentic domain-relevant scenarios, plausible choices / characters	Facts, dialogue, choices based on real events, / dilemmas, authentic roles
Feedback	No in-game responses or minimal cues (e.g. score totalled at end)	Simple points or icons (e.g. stars, badges, timers) indicate success without context	Blended feedback combining scores with contextual reactions / system prompts	Gameplay consequences / system outcomes reflect player actions	Specific, real time feedback, fully embedded in gameplay / scenario itself

Note: To use this matrix, designers should review each of the six design dimensions then select the boxes that best describe how each element is implemented in the game.

All games are likely to include a mix of different levels across dimensions - for example using stylised visuals but realistic feedback. The goal is not to aim for one end of the spectrum, but to deflect deliberately on how each design choice aligns with the audience's context and learning objectives.