Use of Game Design and Game Elements in Serious Project Management Games

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Abstract. Using serious games to teach project management is a logical choice, as it al-lows students to practice skills without facing real-world economic or hu-man consequences. These games offer a realistic learning environment where players can experiment with different ideas and retry projects after failure. Additionally, game-based learning enhances learning outcomes, motivation, and engagement. However, to fully realize these benefits, serious games must incorporate established game design principles and elements. This paper presents a literature review examining how well existing project management games apply such principles. The study analyzes 64 games using Malone's Taxonomy for Intrinsic Motivation, the GameFlow framework, eight reward systems, and other recognized game design elements.

Keywords: Game-based Learning, Serious Games, Project Management.

1 Introduction

Project management (PM) is challenging to teach because it requires practical experience in managing unpredictable events, people, tools, and processes. Poor PM can be costly, leading to resource overruns, delays, and, in extreme cases, project failure. The growing complexity and uncertainty in project environments highlight the need for more focus on PM education [1]. However, increased knowledge alone will not resolve these challenges; it also requires training in applying that knowledge effectively in real-world scenarios [2]. Since project managers make daily decisions on schedule, quality, risks, and resources, soft skills are essential for success [3]. A viable solution is to train decision-making skills through experimentation [4], without the associated real-world costs or risks [5]. Given that project performance is strongly linked to accumulated experience, practical PM training through games is crucial [6].

One promising solution for effective PM training is video games, as well-designed games are efficient learning tools [7]. Game-based learning enhances learning outcomes, motivation, and engagement [8]. Video games are particularly suited to PM, as they provide a safe environment for experimentation, allowing players to learn from mistakes without financial repercussions [9]. Serious games, such as simulators, can create realistic learning experiences using real project data, closely mimicking the role of a project manager [10]. However, for serious games to be effective learning tools, they must be designed with the same care and attention as successful commercial games. This literature study explores the extent to which serious PM games incorporate established game design principles and elements.

2 Material and Methods

This section describes the research focus, method, and background theory for the study.

2.1 Research Goal, Question, and Approach

The research method in this literature review follows the Goal-Question-Metric (GQM) approach [11], which involves defining the research goal at the conceptual level, formulating research questions at the operational level, and establishing metrics to answer these questions at the quantitative level. In this

study, the metrics consist of data extracted from the literature review. Using the GQM template, the research goal of this study was defined as follows:

The purpose of this study was to investigate how game design and game features are used in serious project management games from the point of view of a researcher in the context of the serious games research community.

The research goal was broken down into the following research questions:

- RQ1: What elements from Malone's Taxonomy are used in serious PM games?
- RQ2: What elements from the GameFlow framework are used in serious PM games?
- RQ3: What reward systems are implemented in serious PM games?
- RQ4: Are serious PM games scripted (linear) or emergent experiences?
- RQ5: What other game design elements are used in serious PM games?

2.2 Research Methodology for the Literature Review

The data to address these research questions was gathered through a systematic review of articles describing serious PM games. This review followed the systematic method outlined in [12], which includes five stages:

1) Development of review protocol: Ensure broad literature coverage, include relevant studies on serious PM games, and synthesize data related to the research questions.
2) Identification of inclusion and exclusion criteria: Include articles published in peer-reviewed international conferences or journals, written in English, and featuring "project management," "serious game," or "gamification" in the title, abstract, or keywords. Exclude non-English, inaccessible, or out-of-scope articles.
3) Search for relevant studies: Four databases were searched (see Table 1). Search string used was: +"project management" AND (+"serious game" OR "gamification").
4) Critical appraisal: The articles were reviewed, with relevant studies added and those outside the scope or duplicates removed. Articles were rejected if they did not focus on teaching project management or if they described the gamification of PM rather than a serious PM game. Sixty-four studies were accepted.
5) Data extraction: All accepted papers were reviewed to extract data relevant to the research questions, which was entered into a spreadsheet. The extraction focused on identifying game design elements by examining each article for terms and descriptions matching the elements outlined in the following section. The analysis was based solely on the text within the articles, without playing the games or viewing game footage.
6) Synthesis: Analyze the spreadsheet data in relation to the defined research questions. For more details and references to papers, see online: https://t.ly/GFWZ5 .

Table 1. Search for Articles

Research Database	Articles found	Articles added to the review
Scopus	221	87
Web of Science	80	12
IEEE Xplore	68	13
ACM Digital Library	11	1
Total	**380**	**113**

2.3 Motivational and Game Design Theory

Well-designed video games can be highly effective learning machines, as they are so engaging and motivating that the player learns without been aware of it [7]. The challenge for serious games is to

balance the pedagogical with the engaging elements. This section will present some theories, frameworks, and game design elements that have proven to increase engagement and enjoyment of games used in our study analysis.

Malone's taxonomy of intrinsic motivation focuses on what makes an activity enjoyable or rewarding for its own sake, rather than through external rewards [13]. This taxonomy, grounded in experiments and theories of intrinsic motivation, highlights three key characteristics. First, learning games must provide a *challenge*, with uncertain outcomes (randomness), so that reaching goals enhances the player's self-esteem. *Fantasy* can increase enjoyment and motivation, while *curiosity* drives the desire to learn, independent of specific goals or fantasies [13]. Malone distinguishes between two types of curiosity: sensory curiosity, which uses changes in stimuli like light and sound, and cognitive curiosity, which motivates players by presenting incomplete or inconsistent information—similar to how crime novels gradually reveal plots. In our literature review analysis, we assessed whether the games incorporated these elements: challenge, uncertainty, fantasy, sensory curiosity, and cognitive curiosity.

The **GameFlow framework** is a model designed to evaluate player enjoyment in games [14], drawing from Csikszentmihalyi's flow theory [15]. GameFlow identifies eight elements that contribute to game enjoyment: *Concentration* – the game must require and support focus; *Challenge* – games should offer challenges that match player skill levels; *Player Skills* – games should foster skill development and mastery; *Control* – players need to feel a sense of control over their actions; *Clear Goals* – games must provide clear, timely goals; *Feedback* – players should receive relevant feedback at appropriate times; *Immersion* – games should create deep, effortless involvement; and *Social Interaction* – games should enable and encourage social interactions. Our study analyzed how serious PM games incorporated these eight elements.

Reward systems are crucial for making games enjoyable and motivating. Wang and Chuen-Tsai identified eight reward types from their research on motivation and games [16]: *Score* – use of points that do not affect gameplay directly; *Experience Point (XP)* – earned during gameplay, allowing players to level up when goals are achieved; *Item Granting* – providing graded items that players can use; *Resources* – valuables that players can collect and use to affect gameplay (e.g., virtual wood, extra life); *Achievements* – titles or badges earned by fulfilling specific conditions; *Feedback Messages* – instant positive feedback for successful actions; *Plot animations and pictures* – advancing the game's story during key events or achievements; and *Unlocking mechanisms* – giving players access to new content when requirements are met. We classified the reward systems in serious PM games based on these categories.

Our analysis also included well-known game design elements found in existing games [17-19]. These elements, used in the literature review, include: *Time pressure* – creating urgency to increase engagement [20, 21]; *Levels* – representing game sessions that progress in difficulty; *Inventory* – allowing players to store and use items; *Non-playable characters* (NPCs) – characters controlled by the computer; *Avatars* – playable characters representing players; *Role Play* – where players assume roles of interacting characters; *Quest* – rewarded tasks players can complete; *Appointment* – tasks to be completed later in the game; *Narrative* – the story or story elements within the game; and *Gambling* – where players risk something of value in hopes of winning more. Additionally, our literature review classified the games as either *scripted* (linear) or *emergent* [22]. *Scripted* gameplay guides players through pre-defined actions, while *emergent* gameplay is driven by global rules that lead to unpredictable gameplay experiences.

3 Results

Our literature review identified 64 serious games that met the study's criteria, all focusing on project management (PM). However, they varied in specific areas, as shown in Table 2. Approximately half of the games centered on software PM, one-third on general PM, and one-fifth on construction PM.

Table 2. Focus on Specific Domains in Serious PM Games.

Specific Domain	Count	Percentage	Citations	Citation %
Construction Project Management	11	17%	336	14%
Entrepreneurship Project Management	1	2%	0	0%
General Project Management	18	28%	520	22%
Information Technology Project Management	1	2%	4	0%
Insurance Project Management	1	2%	3	0%
Software Project Management	31	48%	1439	62%
Sustainability Project Management	1	2%	32	1%

Table 3 offers an overview of the mediums and user interfaces used in the reviewed games. The majority (56%) were digital games for PCs, 31% were web-based, and 5% ran on mobile devices. Physical games mainly consisted of board games, with some in-real-life (IRL) exercises and card games.

Table 3. Medium and User Interfaces Provided by the Games.

Medium	User Interface	Count	Percentage
Digital	38% No game UI, 18% Some game UI, 44% Game UI	39	61%
Hybrid	43% Board, 57% IRL exercise + sim, tools, Lego	7	11%
Physical	78% Board, 11% Card, 17% IRL exercise	18	28%

3.1 Support for Malone's Taxonomy for Intrinsic Motivation

Table 4 highlights how these games support elements of Malone's taxonomy. More than half incorporate *uncertainty* (randomness), which aims to enhance realism rather than motivation. Over one-third offer *sensory curiosity* through graphics, animation, and audio. Several games also include *fantasy* elements or adaptive difficulty (*challenge*) settings to optimize the player experience.

Table 4. Support for Malone's Elements for Intrinsic Motivation.

Characteristics	Count	Percentage
Malone's taxonomy for intrinsic motivation is mentioned	3	5%
Challenge (difficulty settings, adapted challenge level)	12	19%
Uncertainty (random)	35	55%
Fantasy	16	25%
Sensory Curiosity	22	34%
Cognitive Curiosity	6	9%

3.2 Support for GameFlow

Table 5 outlines how the games reviewed support elements of the GameFlow framework. Social interaction is the most supported feature, present in 61% of the games. Nearly half (49%) offer collaborative, team-based experiences. Other social interaction features include scoreboards (18%), team vs. team (15%), player vs. player (15%), and collaboration among teams (3%).

Table 5. Support for GameFlow.

Characteristics	Count	Percentage
GameFlow theory is mentioned	0	0%
Challenge (difficulty settings, adapted challenge level)	12	19%
Concentration	8	13%
Player Skills	7	11%
Control	10	16%
Clear Goals	15	23%
Feedback	25	39%
Immersion	3	5%
Social Interaction	39	61%

3.3 Support for Reward Systems

Table 6 highlights the use of reward systems in the reviewed games. *Scoring* systems are the most common, featured in 69% of the games, with various metrics such as points, time, money, cost, quality, letter grade, correct moves/decisions, total earnings, revenue, stars, ranking, and XP. Additionally, 20% of games use *leaderboards* for score comparison. *Feedback messages*, provided in 11% of the games, rank as the third most common reward system.

Table 6. Support for Reward Systems.

Reward System	Count	Percentage
Leaderboard	13	20%
Score	44	69%
Experience Points (XP)	5	8%
Item Granting	0	0%
Resources	0	0%
Achievements	5	8%
Feedback Message	7	11%
Plot Animations/Pictures	2	3%
Unlocking	1	2%

3.4 Scripted or Emergent Gameplay

Table 7 compares the ratio of scripted to emergent gameplay in the games. While most games are characterized as *scripted* or linear, many incorporate both scripted and emergent elements. The prevalence of *emergent* gameplay is largely due to the use of simulators, where models dictate the interaction of elements. Random elements are often introduced to make the games less predictable and less scripted.

Table 7. Scripted or Emergent Gameplay.

Characteristics	Count	Percentage
Scripted (linear)	39	61%
Emergent	25	39%

3.5 Support for Other Game Design Elements

Table 8 highlights additional game design elements used in the surveyed games. The most common features were *levels* and *role-playing*, both present in 25% of the games. These were followed by *narrative* elements, *NPCs*, and *time pressure*.

Table 8. Support for Other Game Design Elements.

Game Design Element	Count	Percentage
Time Pressure	9	14%
Levels	16	25%
Inventory	1	2%
Non-Playable Character (NPC)	11	17%
Avatar	7	11%
Role Play (Role-playing elements)	16	25%
Quest	1	2%
Appointment	1	2%
Narrative	15	23%
Gambling	1	2%

4 Discussion

Adding more game design elements to serious games does not automatically improve them, but it can increase the chances of making the game more enjoyable, immersive, and motivating, which can, in turn, enhance learning. This section examines how much emphasis serious PM games place on game design and its elements.

Regarding game UIs, our analysis shows that most serious PM games lack a proper game UI, instead focusing on simulation or business-style interfaces. This holds true for both digital and physical/hybrid games. Notable exceptions that offer more sophisticated game UIs include PMG-2D [23] and SimSE [24]. An evaluation of PMG-2D with 35 professionals yielded highly positive feedback: 88% found the game design attractive, 92% felt motivated to learn more about project management, 76% lost track of time while playing, 80% expressed a desire to play again, and 84% reported increased knowledge of project management. Similarly, SimSE showed significant learning outcomes in PM and was generally considered enjoyable, though it was critiqued for being repetitive and requiring instruction to play effectively.

Only three papers explicitly mentioned using Malone's taxonomy in their game design. The most common elements were *randomness* (55%), *sensory curiosity* (34%), *fantasy* (25%), and *challenge* (19%). In many cases, randomness was added to simulate a realistic project environment rather than to increase engagement. Since Malone's characteristics can make games more engaging and fun, there is significant untapped potential here. For example, Sharkworld is a pervasive PM game that effectively applies Malone's taxonomy [25]. Although its evaluation was limited, results showed that 83% of players felt the game enhanced their knowledge, 100% reported it captured their attention, and 83% were satisfied with the experience. However, only 14% believed the game improved retention.

Most games in our study also lack support for various GameFlow elements. *Social interaction* (61%), *feedback* (39%), and *clear goals* (23%) were the most commonly used features, but none of the reviewed papers explicitly mention the GameFlow framework. Only 5% of the papers highlighted immersion as a design goal. Since GameFlow is focused on creating immersion and player enjoyment, it is clear that there is significant potential to improve player experience in these games.

Similarly, the focus on reward systems in these games is limited. While 69% of games include a *scoring* system, most are designed to provide educational feedback rather than to motivate or engage players. Common scoring methods include points, and combinations of time and cost, but only 20% of games

featured leaderboards. Other reward systems, such as *feedback messages*, *experience points (XP)*, *achievements*, *plot animations*, *unlocking*, *item granting*, and *resources*, were rarely used. ATIC, for instance, uses a diverse array of rewards, including leaderboards, points, XP, achievements, and feedback messages [26].

As for other game design elements, many remain underutilized. Features like *levels*, *role-play*, *narrative*, and *time pressure* were only used by 25% or fewer games. Elements such as *inventory*, *quests*, *appointments*, and *gambling* appeared in just a few games. Surprisingly, only 11% of the games offered avatars for player representation, despite their potential to enhance immersion. A notable exception is "My Life as a Software Engineer", which included levels, NPCs, avatars, role-play, and a narrative [27]. This game showed significant educational benefits, with a 43% increase in knowledge and a high player rating (Mean = 4.22 on a 5-point Likert scale). However, despite featuring many design elements, the gameplay remained relatively simple, focusing heavily on answering multiple-choice questions.

Our review of 64 serious PM games revealed a limited emphasis on game design elements that could enhance player enjoyment and immersion, which in turn could improve learning motivation and outcomes. Notably, we did not identify a single serious game that matched the quality of well-designed, popular entertainment games. Additionally, the limited evaluation of these games makes it difficult to assess the impact of game design on the overall learning experience. More research and development are needed to explore how game design can better support educational effectiveness in serious PM games.

One limitation of this study is that the analysis is based on textual descriptions of the games rather than direct gameplay. Some games may contain more design elements than were identified in the study.

5 Conclusion

The goal of this study was to explore how game design and features are applied in serious PM games. The findings revealed that only three papers explicitly referenced Malone's taxonomy, with most games neglecting key elements apart from *uncertainty* (randomness) (RQ1). Even in games incorporating *challenge*, *fantasy*, and *curiosity*, these elements were often inadequately designed and implemented. Similarly, most games supported only *social interaction* and *feedback* from the GameFlow framework, with minimal attention to other elements (RQ2). This suggests that serious PM games tend to prioritize simulation and learning over player enjoyment and engagement.

In terms of reward systems, most games featured a basic *scoring* system, with around 20% offering a *leaderboard* (RQ3). Few games incorporated other reward mechanisms like *feedback messages*, *XP*, *achievements*, or *unlocking features*. The study also found that 61% of the games followed *scripted* or linear gameplay, while 39% offered *emergent* gameplay (RQ4), largely due to their simulation-based features.

Finally, support for additional game design elements was limited. The most frequently used elements were *levels*, *role-playing*, *narrative*, *non-playable characters* (NPCs), and *time pressure* (RQ5). This highlights an untapped potential to enhance player enjoyment, engagement, and motivation in serious PM games. Future research should explore the broader application of game design principles in serious games and investigate how these elements can be leveraged to maximize educational outcomes.

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