How Role-Playing Games Have Been Designed for Software Engineering Learning: A Rapid Review

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Abstract. *Software developers require both technical and soft skills to deliver high-quality software on time and within budget. As a result, students must acquire these competencies. However, maintaining student motivation and engagement in learning and practice remains a significant challenge. Game-Based Learning (GBL) has emerged as a strategy to help address this issue. This paper presents a rapid review aimed at understanding how role-playing games (RPGs) have been designed to support Software Engineering (SE) education. The reviewed RPGs include both digital and non-digital formats and have been applied to SE as a whole or to specific subtopics. These approaches addressed both hard and soft skills. While game design theories were not employed in all cases, most of the studies were grounded in learning theories.*
Keywords *Software Engineering, GBL, RPG, Serious Game*

1. Introduction

Software systems are important resources for modern society. Therefore, software developers must possess both hard and soft skills to deliver high-quality software within the specified time and budget constraints. This requires developers to be proficient in executing production and management activities in Software Engineering (SE), to use SE technologies effectively, to communicate clearly, to collaborate with others, to work in teams, and to make decisions [Shaw 2000].

In undergraduate Computer Science programs, SE is typically taught as one or more dedicated courses. These courses provide students with the opportunity to acquire the necessary hard and soft skills in SE [Ouhbi e Pombo 2020]. However, a key challenge lies in motivating and engaging students to complete the tasks required to develop these skills [Maxim et al. 2019].

Various active learning strategies have been created to motivate and engage students, and Game-Based Learning (GBL) of one of them [Plass et al. 2020]. GBL use is justified by the widespread popularity of games among young people [Lenhart et al. 2008]. Given its advantages, GBL has been increasingly adopted in SE education [Souza et al. 2018].

This study employs a Rapid Review methodology [Cartaxo et al. 2020] with the following objectives: (1) to identify the RPG styles used for SE education; (2) to analyze the RPG characteristics incorporated; (3) to determine the SE subjects and soft skills

addressed; (4) to identify the learning and teaching theories applied; and (5) to explore the game development knowledge utilized in designing these games. The main contribution of this work is a detailed analysis of how RPGs have been designed to support SE learning.

The remainder of this paper is organized as follows: Section 2 presents background information on SE subject matter, soft skills, GBL, and RPGs. Section 3 describes the Rapid Review methodology. Section 4 discusses the results. Section 5 presents the threats to validity. Finally, Section 6 presents the conclusions.

2. Background

In academic settings, SE is taught to prepare students to develop high-quality software systems within time and budget constraints. SE encompasses hard and soft skills [Werbach e Hunter 2024]. Hard skills refer to technical competencies related to software development, while soft skills involve the interpersonal attributes required for effective collaboration and professional conduct.

Role-playing (RP) refers to the act of behaving and making decisions in accordance with an assigned role. It enables individuals to experience various social roles—both positive and negative—without facing real-world consequences [Zurcher 1983, Zagal e Deterding 2018a].

A role-playing game (RPG) builds upon the concept of RP but adds a structured framework involving a narrative, characters, and interactions among them [Hammer et al. 2018]. Like other games, RPGs are governed by rules that must be followed throughout gameplay. Players assume the roles of characters and contribute to the progression of the story by overcoming challenges and evolving their characters. As characters advance, players are able to confront increasingly complex challenges. RPGs typically lack a predefined narrative path or fixed conclusion [Zagal e Deterding 2018a]. The four primary RPG styles are: (1) Tabletop RPGs (TRPGs), (2) Live Action RPGs (LARPs), (3) Digital RPGs (DRPGs), and (4) Massively Multiplayer Online RPGs (MMORPGs) [Zagal e Deterding 2018b].

Within the Game-Based Learning (GBL) paradigm [Plass et al. 2020], RPGs have long been used as educational tools to teach a variety of subjects across different knowledge areas [Prager 2019], including Computer Science [Toth e Kayler 2015] and Software Engineering [Souza et al. 2018]. The primary rationale is that RPGs provide students with opportunities to engage in realistic, simulation-based environments where they can develop higher-order thinking skills. This stands in contrast to drill-and-practice games, which typically focus on memorization [Prager 2019, An e Cao 2016]. Furthermore, RPGs are particularly effective for cultivating soft skills such as communication, problem-solving, and leadership [Cheville 2016].

3. Methodology

A Rapid review (RR) is a variation of systematic review, typically employed when there are constraints such as limited time, budget, or available researchers to perform a systematic review [Cartaxo et al. 2020]. Unlike ad hoc literature reviews, RRs adopt a subset of the structured procedures used in systematic reviews for identifying and analyzing primary studies.

Designing educational games requires expertise in three domains: (1) game development, (2) education, and (3) the target subject matter. Game development knowledge is essential for creating engaging and functional games. Pedagogical knowledge is needed to define learning objectives and design activities that guide students in achieving those objectives.

Accordingly, the objectives of this RR were to: (1) identify the RPG styles used to teach SE; (2) examine the RPG characteristics implemented; (3) identify the SE-related hard and soft skills addressed; (4) determine the learning theories adopted; and (5) identify the game development knowledge applied in the design of the reviewed approaches. Based on these objectives, the following research questions (RQs) were formulated:

- **RQ1**: What styles of RPGs have been used to teach SE?
- **RQ2**: What RPG characteristics have been implemented?
- **RQ3**: What game development knowledge has been applied?
- **RQ4**: What SE hard and soft skills have been addressed?
- **RQ5**: What learning theories have been employed?

3.1. Search Approach

The search was based on the following topics and keywords for papers written in English.

- **Software Engineering**: "software engineering", "software development".
- **Education**: "education", "learning", "teaching", "training".
- **Role Playing Game**: "role-playing game", "rpg".

The search string was:

("software engineering" OR "software development") AND ("education" OR "learning" OR "teaching") AND ("role-playing game" OR "RPG")

The search was performed in the Scopus Database (www.scopus.com).

3.2. Inclusion Criteria

For this study, the following inclusion criteria were used.

1. The paper must be related to Software Engineering.
2. The paper must mention RPG as part of the approach.
3. The paper must be a primary study.
4. The paper must have results.
5. The article should be written in English (given its intended submission to an international forum).
6. The paper must have been published in a journal or conference proceedings.

3.3. Exclusion Criteria

For this study, the following exclusion criteria were used.

1. The paper must not be about the same approach presented in another study.
2. The paper must not be a comparison of different approaches.

3.4. RPG Analysis

An RPG has a set of characteristics that differentiate it from other types of games. In this study, a list of core requirements was defined based on the RPG features outlined by Hitchens and Drachen [Hitchens e Drachen 2008]. These requirements are described below.

1. **Evolving Story**. The game must have a storyline that progresses over time.
2. **Explorable Game World**. The game must provide a world that supports the narrative and is expansive enough for player exploration. Characters should be able to revisit previously explored areas.
3. **Sequence of Events**. A chronological or logical sequence of events should be embedded within the game world, giving the game a coherent narrative structure.
4. **Characters**. The game should include player characters with distinct roles, traits, and abilities that reflect their identities within the game world. Players must assume one or more such characters. The game must also include non-player characters (NPCs).
5. **Game Master**. There must be one or more Game Masters (GMs), or a game engine, responsible for guiding the narrative and enforcing the rules. GMs may also take on the roles of NPCs.
6. **Player Agency**. Players should influence the course of the game through their decisions and actions, actively shaping the game's narrative and world state.
7. **Free Interaction**. Players must be able to interact freely with the game world through their characters. This includes at least dialogic interactions and interactions with objects.
8. **Character Development**. Players must have opportunities to develop their characters' skills. This development can be either quantitative (e.g., leveling up) or qualitative (e.g., acquiring new abilities or traits).
9. **Challenges and Tasks**. The game must present challenges to overcome and tasks to complete. These may relate to story progression or character development. Resources may assist players in addressing these challenges. Player actions can succeed or fail based on game mechanics.
10. **Economic System**. The game should incorporate an economic system in which players acquire resources (e.g., gold or currency) that can be used to purchase items necessary for completing tasks or overcoming challenges.
11. **Resources**. The game should provide resources that players can obtain through exploration, purchase, or as rewards. These resources should aid in task execution or challenge resolution.
12. **Rewards**. Players should receive rewards upon successfully completing tasks or overcoming challenges, reinforcing progress and encouraging continued engagement.

4. Results and Discussion

The search process identified 32 papers. After applying the inclusion and exclusion criteria, 10 studies were selected for analysis: (1) [Ohlsson and Johansson 1995], (2) [Zuppiroli et al. 2012], (3) [Long and Young 2011], (4) [Wu et al. 2016], (5) [Marín et al. 2018], (6) [Warin et al. 2016], (7) [Rueda et al. 2016], (8) [Montenegro et al. 2017], (9) [Shi et al. 2023], and (10) [Wu et al. 2008]. Each of these studies was carefully reviewed.

The selected approaches were categorized into three levels of RPG application: (1) applied throughout an entire course (studies 3, 9, and 10); (2) used within the scope of a software project (studies 1, 2, and 6); and (3) focused on specific subjects within Software Engineering (studies 4, 5, 7, and 8).

4.1. RQ1: What styles of RPGs have been used to teach SE?

Four of the selected approaches (40%) were classified as CRPGs (studies 4, 5, 8, and 10). The remaining six approaches (60%) were categorized as TRPGs, as they involved non-digital RPG formats. At first glance, these non-digital approaches might resemble LARP, since students assume roles related to software projects and perform corresponding tasks in real-world contexts. However, several key differences prevent their strict classification as LARPs. Traditionally, LARPs require a large physical setting and assign each participant a single NPC, typically distributed across the space. Furthermore, LARPs often involve multiple individuals acting as GMs. In contrast, in many of the reviewed approaches, the instructor took on multiple NPC roles, and all participants—including the teacher—generally occupied the same physical space.

In traditional TRPGs, players typically gather around a table, and gameplay unfolds entirely within that localized environment. Campaigns may span several weeks or months, with players recording their progress to resume in later sessions. However, game-related activities rarely occur between sessions. By contrast, in the non-digital RPGs designed for SE education, students are frequently required to complete tasks between sessions, often in different physical contexts, such as at home.

In this study, the non-digital RPGs were classified as TRPGs due to their significant resemblance to that format. Nevertheless, the educational RPGs reviewed occupy a conceptual space between TRPG and LARP, incorporating elements from both to support learning objectives in Software Engineering.

4.2. RQ2: What RPG characteristics have been implemented?

Table 1 presents the analysis of RPG characteristics addressed. A "Y" (Yes) indicates that the requirement was fulfilled, while an "N" (No) indicates that it was not.

Table 1. Characteristics of the RPG approaches.

Requiremments	Studies										
	1	2	3	4	5	6	7	8	9	10	%
Evolving story	Y	Y	Y	N	N	Y	Y	N	Y	Y	70
Explorable game world	Y	Y	Y	Y	N	Y	Y	N	Y	N	70
Sequence of events	Y	Y	Y	Y	N	Y	Y	N	Y	Y	80
Game master	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
Player character	N	N	N	Y	Y	N	N	N	Y	Y	40
Player agency	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	90
Wide range of interaction	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	90
Character development	N	N	Y	N	Y	N	N	N	N	N	20
Challenges	N	N	Y	N	Y	N	N	N	Y	N	30
Tasks	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
Economic system	N	N	Y	N	N	N	N	N	Y	N	20
Resources	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100
Rewards	N	N	Y	N	Y	N	N	N	N	N	20

An evolving storyline is a fundamental characteristic of RPGs. This requirement was met by 70% of the analyzed approaches (studies 1, 2, 3, 6, 7, 9, and 10). Notably, these storylines were structured around software project scenarios, resembling Project-Based Learning (PjBL) [Markula e Aksela 2022]. For this review, such project-based scenarios were considered valid representations of evolving narratives.

Another key feature of RPGs is the freedom players have to explore the game world. In 70% of the approaches, this world was tied to a software project, suggesting that students had the autonomy to interact in order to perform SE tasks. Among the four digital RPGs analyzed (studies 4, 5, 8, and 10), only study 4 incorporated a truly explorable game world.

While exploration is essential, a meaningful RPG experience also requires a coherent sequence of events to support narrative progression. As software projects inherently involve task sequences, 80% of the reviewed approaches (1, 2, 3, 4, 6, 7, 9, and 10) were considered to fulfill this requirement.

The role of the GM is also central to RPGs. In non-digital games, the GM orchestrates the narrative, enforces rules, and embodies NPCs. In digital formats, these functions are handled by the game engine. All reviewed approaches included either a human GM or a digital engine fulfilling this role.

According to Hitchens and Drachen [Hitchens e Drachen 2008], players in RPGs should assume characters with distinct traits and abilities, not merely roles. Only four approaches (studies 4, 5, 9, and 10) (40%) met this criterion, and three of these were CRPGs. However, none of them explicitly incorporated character-specific traits or abilities into gameplay. Moreover, in most cases (60%), students performed predefined roles instead of playing characters (studies 1, 2, 3, 6, 7, and 8).

Player agency is the ability to influence the game's progression through decisions and actions, and it is a defining feature of RPGs. Nearly all approaches (90%) enabled such agency by simulating software project execution. Only study 5 lacked this characteristic, offering a more linear gameplay experience.

A wide range of interaction types, particularly dialogue, is also expected in RPGs. This interaction typically occurs between the player's character and NPCs or in-game objects. Only study 5 lacked character-based interaction. Given that most games were based on software projects, 90% were considered to meet this requirement.

Character development is another essential RPG element, allowing characters to grow and face increasingly complex challenges. Only two approaches (studies 3 and 5) (20%) supported this feature. In the majority of cases (80%), students performed evolving roles, but the characters themselves did not improve. Instead, the players developed their own SE knowledge and skills through course or project progression.

All approaches included tasks to be completed, typically aligned with software project activities. Challenges, however, were present in only 30% of the studies (3, 5, and 9). In study 3, challenges were tied to topics not covered in class. In study 5, they involved modeling a main character, understanding class diagrams, and correcting flawed diagrams. Although not explicitly stated, the framework in study 9 supports challenge creation.

An economic system adds strategic complexity to gameplay by enabling players to acquire resources needed for progression. Only two studies (3 and 9) (20%) incorporated such systems. In study 3, a virtual marketplace allowed students to purchase tools required for task completion. Similarly, study 9 included a reward-based currency system used to buy virtual goods.

In entertainment RPGs, resources such as weapons and potions help players overcome challenges. In SE-focused RPGs, resources refer to tools like text editors or modeling software. All approaches (100%) included the use of such resources.

Rewards are crucial for maintaining player motivation. Only two approaches (studies 3 and 5) (20%) explicitly incorporated reward systems. In study 3, players earned "knowledge gold" for task completion and productivity, as well as "experience points" for SE-related achievements. In study 5, players unlocked new robot components upon completing missions.

4.3. RQ3: What game development knowledge has been applied?

For an RPG to be effective, it is essential to incorporate principles from game development theory. This consideration remains relevant even when the RPG is designed primarily for teaching and learning purposes. However, only 30% of the reviewed approaches (studies 3, 5, and 9) explicitly applied such theories.

Study 5 adopts the Mechanics, Dynamics, and Aesthetics (MDA) framework [Hunicke et al. 2004], a widely recognized model in game design. Study 3 draws inspiration from elements commonly found in Massively Multiplayer Online Role-Playing Games (MMORPGs), such as narrative structure, virtual marketplaces, and time-based pressure. Meanwhile, study 9 is grounded in Werbach and Hunter's game design framework, which emphasizes components, mechanics, and dynamics [Werbach e Hunter 2012].

4.4. RQ4: What SE hard and soft skills have been addressed?

The hard skills addressed in the selected studies are summarized in Table 2. Most of the studies (60%) focused on general software development and project management activities (studies 1, 2, 3, 6, 7, and 10). Requirements specification was the most frequently addressed software development activity, appearing in 60% of the studies.

Process-related topics, such as process models and management, were addressed in study 3, while study 6 introduced students to the *Two-Track Unified Process*. Cost and time estimation were explored in more detail in studies 1 and 4. The use of software engineering tools was incorporated into studies 1, 2, 3, and 9. Risk estimation was addressed in study 4. Modeling activities were given particular attention in studies 1 and 3, and software architecture was covered in study 8. System documentation was emphasized in studies 1 and 3. Study 5 focused on the understanding and use of UML class diagrams. Software maintenance and quality management/assurance were core topics in study 1. Test-driven development was explored in study 9.

Soft skills were addressed in seven studies (studies 1, 2, 3, 6, 7, 8, and 10) (70%), as shown in Table 3. The most frequently emphasized soft skill was teamwork, covered in 60% of the studies (1, 2, 3, 6, 7, 10). Other soft skills addressed were: keep promises (1),

Table 2. Hard skills covered in the studies.

Subject	Studies
Process	3, 6
Software development activities at all	1, 2, 3, 6, 7,10
Project management activities at all	1, 2, 3, 4, 6, 10
Evaluation of cost and time	1, 4
Requirements specification	1, 2, 3, 4, 6, 7
Risk estimation	4
Software architecture	8
System documentation	1, 3
Quality management/assurance	1, 9
UML class diagram	5
Software maintenance activities	1
Software product line	2
Test driven development	9
Software engineering tools	1, 2, 3, 9

face maintenance problems (1), make decisions (4, 8, 10), interaction and communication (4, 6), collaboration (2, 10), negotiation (1, 8), solving project problems (1), respect of deadlines (2), accounting and monitoring of work (6), distribution of tasks (6), holding of meetings (6), scheduling (6), and allocation of individual or collective work (6).

Table 3. Soft skills covered in the studies.

Soft Skill	Studies
Keep promises	1
Work in teams	1, 2, 3, 6, 7, 10
Face maintenance problems	1
Decision making	4, 8, 10
Interaction	2, 6
Communication	2, 6
Collaboration	2, 10
Negotiation	1, 8
Solving project problems	1
Respect of deadlines	2
Accounting and monitoring of work	6
Distribution of tasks	6
Holding of meetings	6
Scheduling	6
Allocation of individual/collective work	6

4.5. RQ5: What learning theories have been employed?

The learning theories adopted in the selected studies are summarized in Table 4. These theories were explicitly applied in 60% of the approaches (studies 1, 4, 5, 6, 9, and 10).

A practice-driven education was adopted in study 1. This practice is based on the theory that knowledge cannot be taught but must be built by each individual. In their approach, an RPG was applied to support students in learning software development through experience-based engagement.

In study 4, the researchers applied the Experiential Learning Cycle (ELC) [Kolb e Kolb 2011]. The ELC comprises four stages: concrete experience, reflective

Table 4. Education approaches used.

Learning Approaches	Studies
Practice-Driven Education	1
Experiential Learning Theory	4
Project-Based Learning	6
Gamification	9
Technological Pedagogical Content Knowledge	10
Game-Based Learning/Serious Game	5, 10

observation, abstract conceptualization, and active experimentation. In their study, RPG mechanics were utilized to engage students in defining software requirements and estimating cost and time. Study 6 was originally based on PjBL, with an RPG used to simulate a software project. Study 9 introduced a gamification-based framework to structure a course as an RPG.

Study 5 introduced a serious game designed to support students in learning Unified Modeling Language (UML) class diagrams. As serious games are inherently educational, this approach aligns with the principles of Game-Based Learning (GBL). Similarly, study 10 is grounded in Digital Game-Based Learning (DGBL) and incorporates the Technological Pedagogical Content Knowledge (TPACK) framework [Koehler et al. 2004].

In the remaining studies (2, 3, 7, and 8) there is no explicit mention of the application of learning theories in the design or implementation of the proposed approaches. However, since all of them incorporate RPGs or RPG-based concepts, they can be classified under GBL. A few specific observations can be made about these approaches. The method presented in study 2 was implemented within a project laboratory setting. While the authors refer to active learning, they do not explicitly indicate the use of any particular learning theory. Although the proposal is framed as an RPG, its structure and execution resemble more closely a PjBL approach. Similarly, in study 3, the researchers do not explicitly state the use of a learning theory, but their method incorporates characteristics of MMORPGs to engage learners. Lastly, approaches 7 and 8 also do not mention the use of learning theories in their descriptions. Notably, the ATAM-RPG presented in study 8 is designed as a serious game. Therefore, this game is in the context of GBL.

5. Threats do Validity

The search was limited to studies explicitly mentioning Software Engineering, which resulted in a more restrictive search string. However, RPGs have also been used to teach specific SE topics, such as requirements engineering and software design, which may not have been captured. Additionally, the search was conducted exclusively in the Scopus database.

6. Conclusion

Role-playing games have been used to support the teaching of both hard and soft skills in SE. These games may take either digital or non-digital forms. The non-digital RPGs analyzed in this study were categorized TRPGs. However, their characteristics place them between TRPG and LARP, as they incorporate elements of both.

This study defined a set of core RPG requirements, including: an evolving story, an explorable game world, a sequence of events, player characters, player agency, a wide range of interactions, and character development. None of the reviewed approaches fulfilled all of these criteria. Nevertheless, meeting these requirements is essential—even in educational contexts—particularly when RPGs are used to simulate software project execution. Otherwise, the approach may lose its game-like nature and resemble a traditional PjBL activity, which may include role-playing elements but lacks the interactive and motivational features of a game.

Some of the selected approaches addressed SE as a comprehensive subject, typically through simulations of software projects. Others focused on specific SE topics, such as requirements engineering or software architecture. In all cases, students assumed roles related to the software engineering activities being simulated. In non-digital RPGs, instructors also adopted roles to guide game progression and to define tasks and challenges for students.

Soft skills were included in the majority of the selected studies; however, only two approaches provided substantial coverage of this dimension. Despite the recognized importance of developing soft skills in SE education, most RPG implementations focused primarily on technical competencies. Given that RPGs are well-suited for promoting both cognitive and interpersonal development, future approaches should place greater emphasis on soft skills.

Designing a successful educational game requires not only pedagogical insight but also knowledge of game development principles. However, only three of the reviewed studies explicitly mentioned game design theories. Even in educational contexts such as SE, it is essential to consider principles from game development to enhance student motivation and engagement with the learning content.

While most of the reviewed approaches were grounded in established learning theories, only two explicitly cited GBL as their theoretical foundation. Instead, RPGs were typically integrated within the scope of other educational frameworks. This suggests that although RPGs naturally align with GBL, they are often employed in conjunction with other pedagogical models. Therefore, it can be concluded that GBL is a flexible paradigm that can be effectively combined with various learning theories to support SE education.

Although the effectiveness of the reviewed approaches was not the focus of this study, most reported positive outcomes. Two exceptions were noted: study 3 found no significant differences compared to traditional instruction, and study 7 reported better results in the control group. However, in the latter, students who participated in the RPG activity demonstrated greater motivation and produced higher-quality requirements.

The rapid review also returned studies that referred to role-playing in general, without explicitly labeling their approach as an RPG. Other studies proposed game-based strategies resembling RPGs, but the authors did not classify them as such. These studies were excluded from the current review. Nevertheless, a future review should consider including these borderline cases to better understand the distinctions and outcomes between general role-playing activities and explicit RPG implementations.

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