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Computer Game Scenario Representation: A Systematic Mapping Study

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Abstract

Background: Game scenario is an important factor for achieving player enjoyment; consisting a key business success factor. Additionally, the production of early design artifacts is crucial for the success of the development process. However, representing scenarios is a non-trivial task: (a) multiple aspects of the game need to be visualized; and (b) there is a plethora of representation approaches, out of which the game designer needs to select from.
Aim: The goal of this work is to provide a panorama of the current scenario representation approaches, to aid game engineers in selecting the most fitting scenario representation approach and understand the existing designing options.
Method: We have performed a Systematic Mapping Study, using 4 digital libraries, since the main goal can be achieved through study classification. By following an established search and filtering process, we have identified 717 articles, and analyzed in detail 95.
Results: Diagrams are the most common generic approach to represent scenario; Game story is the most usual part of the scenario being represented; Characters are the most common component; and Transitions are the most usual connectors.
Conclusion: Researchers may get useful information for empirically investigating several game engineering aspects; whereas game engineers can efficiently select the most fitting approach.

Keywords: systematic reviews and mapping studies, software architectures and design

1. Introduction

The rapid technological developments have led to a massive increase of the size of the whole spectrum of digital activities, causing multiple changes to everyday routines of humans. One prolific example of this rise, is the growth and popularity of computer games [1]. Nowadays, computer games are an important part of the entertainment for both children and adults. Children choose to devote more and more time to this kind of entertainment by sacrificing other activities [2]. The large spread of digital games is proven by the enormous availability of game titles and the fact that game industry could compare to that of "*Hollywood industry*" [3]. The games have the ability of attracting the interest and the full attention of gamers, "*making*" 78% of American teenagers to play computer games [2]. According Statista, the revenue from computer and console games is expected to reach $240 billion

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in 2026 from $175 billion in 2022[1]. Although, games form a special kind of software (e.g., the most important factor for their success is user enjoyment and usability, rather than functional correctness and suitability), they still obey to all software engineering principles. In other words, games despite being a collection of graphics, animations, sounds, code, etc. the core product is a collection of code artifacts that needs to be specified (what the game will do), designed (game architecture), implemented (actual coding of classes) and tested (functional, usability, etc.), like any other software solution. Based on this, game analysis and design (e.g., scenario, character definition, etc.) are of paramount importance for the successful implementation of the games, as well as their success.

According to Ham and Lee [4] and Paschali et al. [5] there are seven high-level characteristics that lead to gamers' satisfaction, engaging them to game playing; namely: Scenario, Graphics, Speed, Sound, Control, Characters, and Community. Both papers conclude that Character Solidness, Scenario and Sound are highlighted as the most crucial deciders on if a game will be successful or not. By considering that character building (i.e., definition, relationship, interactions, and so on.) are part of the game scenarios, ***scenarios can be promoted to the most important factor for game success***, since both studies point to this direction. In this work scenario we define the description of the game in terms of plot, world, rules, characters, interaction, and any other element that is required to describe and specify a game. Given the complexity and dynamic nature of scenarios, their representation in game design documents is far from trivial [6]. However, being able to represent a scenario properly at an early design stage is of paramount importance, since: (a) it acts as a ***communication vehicle*** among different development stakeholders, such as: designers, developers, scenario artists, graphic experts, and so on.; and (b) it acts as an early piece of documentation that can be ***easily perceived by end-users and be an artifact for early testing***. One important parameter that needs to be considered before deciding the representation approach, is the game genre (e.g., Action, Adventure, Arcade, Realtime strategy, God Games, Roleplaying, Shooter, Simulations, Sport, Strategy, and so on.). At the design phase, according to the genre of the game, the way to depict the scenario is chosen: along with its components, connectors and so on. More specifically, according to the genre of the games the game rules, world, and mechanics differ substantially. However, in academic literature there are only limited studies that focus on this aspect of game design, despite the fact that game engineering literature is continuously growing [7] . Therefore, interested parties (researchers or practitioners) need to read various articles, only superficially connected to the aspect, and gain unconnected and synthesized knowledge.

Given the above, in this paper we present the first (to the best of our knowledge) mapping study to provide a complete panorama of the research state-of-the-art on scenario representation. In particular, we explore the representation methods, as well as the components and the connectors used in these representations. In Section 2, we present related work including secondary studies in the field of game engineering; in Section 3 the study design; whereas in Section 4 we present and in Section 5 discuss the results. Finally, threats to validity are presented in Section 6; we conclude the paper in Section 7.

[1] https://www.statista.com/outlook/dmo/digital-media/video-games/worldwide

2. Background Information

In this section, we present the necessary background information for facilitating the understanding of this article. We note that we have not identified any study that is directly comparable (direct related work), i.e., a secondary study on game scenarios. We need to note that indirectly related secondary studies (such as: secondary studies on game engineering (e.g., [7], or visualization techniques [8]) are not discussed, since we cannot contrast our findings to them. Therefore, we are focusing on background information on game scenarios.

Game Scenario Importance & Scenario Design: According to Ham and Lee [4] and Paschali et al. [5], game scenario is one of the most important features that lead to player satisfaction. Silva (2019) also emphasized how important fun is in serious games for players to want to continue playing and learning as a result [9]. Zyda [10], in the same reasoning, argued that a serious game must first be fun [10]. Zemliansky and Wilcox [11] also mentioned the need for a balance between art and game design to achieve learning while still creating an enjoyable user experience [11]. Many researches aimed at the narrative structure of a scenario. According to Partlan et al. [12] the automated representation of interactive narrative consists of four types of related graphs: (a) the scene graph, which represents how the scenes connect to each other; (b) the layout graph representing the physical placement of objects in the visual environment; (c) the script graph contains the code to operate the scene's gameplay logic; and (d) the interaction map using static graph analysis [12]. At same path, Segel & Heer [13] after analyzing 58 collected examples from online journals, graphic designs, comics, business, art, and visualization research, they identified distinct genres of visualization using narrative structures such as the martini glass, interactive slideshow, and drill-down story [13]. On the other hand, some developers use flowchart for designing game scenario [14], providing an interface that is easier to adopt, use, debug and tune [15]. A tool that we also met is the Code City that is used to visualize cities in games and gives a great variety of opportunities such as interactivity, scalability, navigation and completeness [16].

According to Fabricatore [17] the gamers focus on: (a) what the player can do; and (b) what other entities can do, in response to player's actions (i.e., how the game responds to player's decisions, this would happen with usage of game mechanics [17]. The importance of interaction through game mechanics was also highlighted [18]. Game content, by focusing on the Procedure Content Generation areas, has six layers [19]: (a) game bits, which are elementary units of game content; (b) game space, the environment in which the game takes place; (c) game systems, to generate or simulate parts of a game; (d) game scenarios the way and order in which game events unfold; (e) game design which consist of goals and rules; and (f) derived content is created as a side-product of the game world. Finally, game design is composed of [20]: (a) Features; (b) Gameplay rules; (c) Learning contents; (d) Interface; and (e) Game Levels. Specifically for scenario design the authors identified that the key elements are: (a) blocking tissues; (b) vital tissues, and (c) targets which are modeled with boxes.

The development of games is characterized by a lack of formalization compared to software development. Park and Park [21] proposed a graph-based representation of game scenarios, a combination of Event graph, State graph, and Action graph forms to eliminate anomalies of game flow design and increase the better communication of game designer and the game programmer. The use of design patterns was suggested by Killi [22], who proposed 6 categories of patterns for serious games: (a) Integration Patterns; (b) Cognitive

Patterns; (c) Presentation Patterns; (d) Social Interaction; (e) Teaching Patterns; and (f) Engagement Patterns [22]. Additionally, Amory [23] proposed a new more detailed model, GOMII, as the new version of GOM which in order to support parameters that educational computer games should have: relevant, explorative, emotive, engaging, include a variety of challenges, democratic, include computer tools that promote dialogue, gender-sensitive, provide non-negotiable results, include correct role models [23]. All these parameters made this model not only a tool for supporting learning process but also an evaluating mechanism of computers' usage into classrooms. Finally, the Game content, focusing on Process Content Creation areas, has six levels according to Hendrikx et al. [19]: (a) game bits, which are elementary units of game content; (b) game space, the environment in which the game takes place game; (c) game systems, to create or simulate parts of a game; (d) game scenarios in the manner and order in which game events unfold; (e) game design consisting of goals and rules and (f) the resulting content is created as a side-product of the game world.

3. Methods

This section presents the protocol of the systematic mapping study. A protocol constitutes a pre-determined plan that specifies the research questions and how the mapping study has been conducted. Our protocol is presented according to the guidelines suggested by Peterson et al. [24], whereas the reporting of the secondary study is based on the SEGRESS guidelines [25] – the checklist is presented in Appendix B.

3.1. Objectives and research questions

According to Goal-Question-Metrics (GQM) format, we set the main goal of the study which is to analyse the representation methods of game scenarios. To fulfil this goal, we have set the followed questions, to study scenario representation from three perspectives: (a) the ways of their representation; (b) the parts of scenarios that are represented; and (c) the components of the scenario and their connection and we set the followed questions.

RQ_1: Which are the most common methods in the academic literature for representing computer game scenarios?

As the scenarios are complex and dynamic, there is a need to find an appropriate way to depict them in game design documents. RQ_1 is related to the identification of the methods for game scenario representation. This question is answered at two levels, since we build a 2-level classification schema. First, we identify the *Generic Representation Type (GRT)*, and in the next step we specify (whenever relevant), a more *Specific Representation Type (SRT)* – e.g., as proposed by the Unified Modelling Language (UML). Examples of SRTs are state-machine, flow chart, activity diagram, class diagram or sequence diagram. For each generic representation type, we explain in detail the meaning, and then we present all the pertaining SRTs.

RQ_2: What parts of the scenario are captured by the representation methods?

RQ_2 is related to the exact parts of the scenario that are depicted in each representation method identified in RQ_1. To answer this question, we separate the scenario into three parts. First, Game Story, which presents the flow of events in the game and captures aspects such as player navigation, the options of the player and so on. Second, Game World that represents the visual elements of the game including the description of the world locations along with the characters and objects they include. Finally, Game Rules that correspond to the mechanics that control the flow of the game. A rule can be related to an action of the player in conjunction with the state of the world the characters and so on. The motivation of this question is to decompose the scenario representation approach selection problem to smaller ones, so as to be more a manageable. The answer to this question will expand the previous schema, by noting the parts of the scenario that can be represented by each GRT or SRT. Based on this, we suggest combinations of representation methods that are able to capture all parts of a scenario.

RQ_3: What elements (components and connectors) are used in the aforementioned representation approach?

In RQ_3 we focus on the different representation methods, and we seek mappings between representation elements (i.e., components and connectors) to game elements. For example, as component we can consider the character of a game and as connector the actions of the character. The reason for asking this question is for creating a checklist of the elements that need to be considered for every part and guiding the scenario design process in a more organized way.

3.2. Search process

Our search strategy has been developed, based on the goal of the study and the set research questions. Based on these, we opted for performing a mapping study, rather than a systematic literature review, since: (a) the topic is broad; (b) we aimed at a generic overview of the topic; (c) the main goal of the study is to provide a classification of scenario representation approaches. Based on the above, we performed an automated search through the advanced search functions of four well-known Digital Libraries (DL): (a) IEEE Digital Library, (b) ACM Digital Library, (c) ScienceDirect; and (d) Scopus. We opted for searching in DL instead of narrowing the search space to specific venues, since we are not interested in specific communities or publication sources (e.g., only software engineering or only graphics). As a first step we applied the search string to the abstract of primary studies in Q1 of 2021, to return all the papers that are relevant to game scenario. The search string is described below:

[**Abstract**: game or gaming] AND
[**Abstract**: visualization or design or depiction or representation] AND
[**Abstract**: scenario]

The decision to apply the search string to the Abstract has been made by piloting that the same search string on the Title misses various important sand highly relevant studies. The main reason for this is that many authors use in the title "Game" or "Scenario", or a specific representation approach (e.g., "Flow Chart"), rather than the terms of the 2nd part of the string (visualization or design or depiction or representation). The alternative to this would have been to search the title for games, and add the scenario representation approach as an inclusion criterion. However, this option would return an unmanageable amount of candidate primary studies (as you will later see the exclusion rate was quite high even for the narrower search string). Another alternative would have been to build a more specific search string that would return less articles that would be more relevant (e.g., by including the expected representation approaches). However, this would have biased our results, since the data collection would not be open ended, and there would be a higher chance of missing papers. Given the two corner solutions (too generic or too specific) search string, we have opted for the middle path which would not bias the results, but would provide a large, but manageable corpus of papers for the IC/EC process. We selected each word and its synonym in order to eliminate the possibility of losing relative articles.

After retrieving the first dataset we defined the Inclusion Criteria (IC) and Exclusion Criteria (EC). A primary study has been selected for inclusion, if it satisfied the first IC and one or more of the rest ICs, whereas it has been excluded from our study, if it satisfied one or more ECs. The inclusion criteria of our systematic mapping are:

- IC1: The primary study is applied in computer games for instance, primary studies referring to "traditional" games, without using a computing system have been excluded;
- IC2: The primary study contains a method of game scenario's representation; we need a paper to present a scenario of a computer game, that is presented using a specific method – ranging from textual descriptions to graphical representations.
- IC3: The primary study presents building blocks that consist the scenario; the scenario is not presented as a complete block, but is separated into parts.

The exclusion criteria of our systematic mapping are:

- EC1: The primary study is written in a language other than English.
- EC2: The primary study is an editorial, keynote, biography, opinion, tutorial, workshop summary report, progress report, poster, or panel.
- EC3: The primary study contains only a part of scenario and not the whole scenario; for example, in a ping pong game only the move of the ball is depicted.

Every article selection phase was handled by one member of the team and possible difficulties were resolved by the other member. For each selected publication venue, we documented the number of papers that were returned from the search and the number of papers finally selected. The main reasons for filtering out papers were: (a) their focus on "real-life" (e.g., original monopoly or physical sport games) and not "computer" games – approximately 40%; or (b) the lack of a specific representation approach – approximately 35%. At the end of the process, we have obtained a dataset of 95 primary studies. An overview of the aforementioned process is provided in Figure 1.

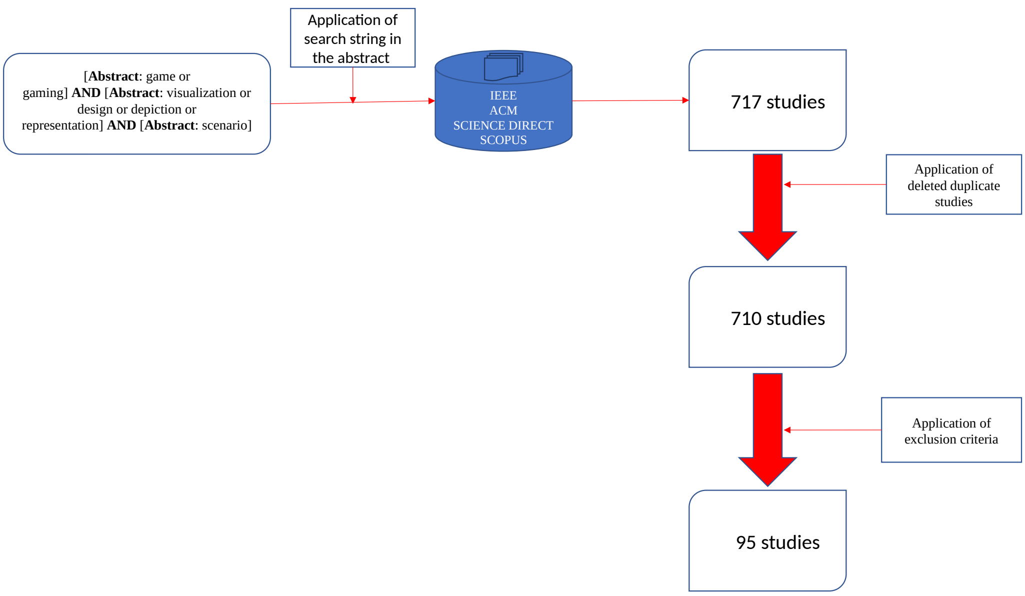

Figure 1. Overview of search process

3.3. Data collection and analysis

During the data collection phase, we collected a set of variables that describe each primary study. Data collection was handled by the first author and possible difficulties were resolved by the second author. For every study, we extracted and assigned values to the following variables:
V1 Title: Records the *title* of the paper.
V2 Author: Records the *list* of authors of the paper.
V3 Year: Records the *publication year* of the paper.
– Type of Paper: Records if the paper is announced/published in a conference or *journal or workshop.*
V4 Publication Venue: Records the name of the corresponding journal or conference.
V5 GRT: Records the *generic scenario representation* approach (e.g., narrative structure, UML)
V6 SRT: Records the *specific scenario representation* approach (e.g., algorithm, Petri-Net, pseudocode)
V7 *Components* of game representation (e.g., characters, dialogs)
V8 *Connectors* of game representation (e.g., link two characters through a dialog)
V9 *Part of the game scenario* that is represented? (e.g., rules, story, game world)

The variables have been selected, based on the set RQs, and they are used to answer them, through 1-to-1 matching, see below. The complete dataset for this study is presented in Appendix A. Appendix A, serves also as the final list of primary studies considered in this work. Due to the large number of scenarios' representation in the literature we performed pre-processing. To group more general categories, we used Open Card Sorting . We have selected to use Open-Card sorting since it is an established method for coding in the literature, it is rather simple and straightforward, and it can be applied by the small number of authors of this research. In particular, we: (a) identified more general categories (e.g., UML generic type) from the scenarios' representation methods in the primary studies; (b) reviewed the methods to find candidates for merging – e.g., we mapped "state machine" as sub-category; and (c) defined the names of the final super-categories and sub-categories. To answer the aforementioned RQs, we chose different ways for presenting the results. More specifically for answering RQ_1 for generic scenario representation approach we present a pie chart and a diagram for combining the generic specification and specific representation approach. For answering RQ_2 we used a pie chart for presenting the frequency of parts of game scenario, a bar chart for parts of scenario represented by generic scenario representation approach and a Venn diagram for representing the parts of scenario represented by specific scenario representation approach. For answering RQ_3 we used two heatmaps: (a) to specify the frequency of connectors used in different scenario representation approaches; and (b) to present generic scenario representation approach with components

4. Results

In this section, we present the results of this study, organized by research question. Therefore, in Section 4.1, we present the most common ways of depicting scenarios in game development (RQ_1). In Section 4.1, we present the parts of the scenarios captured by the representation method (RQ_2). Finally, in Section 4.3, we present the elements (components and connectors) that are used in each game scenario representation approach (RQ_3). As a first step in Table 1, we present a descriptive analysis of the dataset.

Table 1. Descriptive analysis of the dataset

Type of publication	Number of published articles
Articles in Journal	29
Book Chapters	1
Articles in Conference	65
Period	Number of published articles
2002–2005	4
2006–2010	15
2011–2015	31
2016–2020	40
2020–2022	5

4.1. Scenario approaches (RQ_1)

This section answers RQ_1 regarding the ways of scenario's representation. Scenario representation approaches can be classified into a 2-level schema: the first level for general ways of representation, further specified in the second one. In Figure 2, we present all the approaches that are used for scenario representation, through a pie chart, using different colours and labels to represent the different approaches. The most common way of representation is by ***diagrams*** for the purpose of visualization, e.g., in ; followed by ***narrative*** that textually describes the details of a scenario for example in. The Unified Modelling Language (**UML**) is the third choice of researchers, e.g., [26] – although in some cases it could be classified into diagrams as well. By considering the UML is usually expressed in the form of a diagram, the generic "diagram" accounts to more than 50% of representation methods. We preferred to present it as a separate representation way for explicitness. The main advantage of using generic (or UML) diagrams is the visual representation, which is usually for easily perceived by the human cognition. On the other hand, the main benefit of using narrative is that is a form of representation/description that can be produced and read without any prior computer science knowledge (e.g., sound or visual artists, script writers). The ***pseudocode***

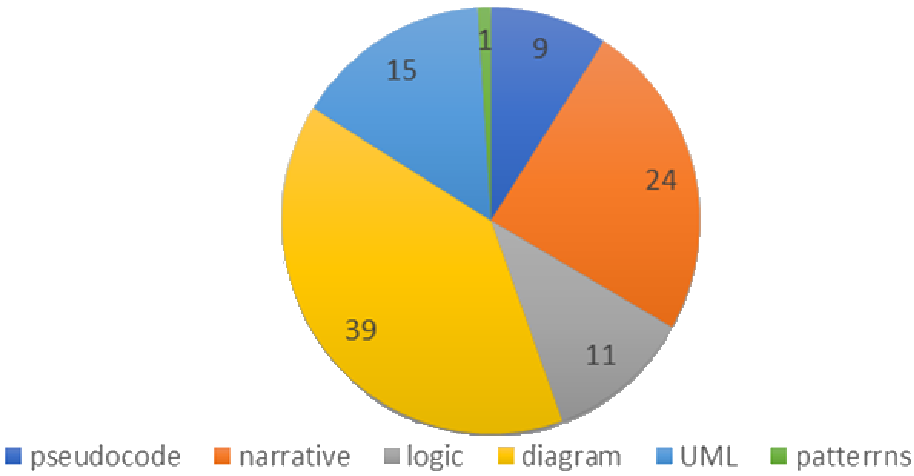

Figure 2. Generic scenario representation approaches

is a program written in "human language" following the programming rules, being used in nine studies for example in [27]. ***Patterns*** and ***logic*** are more rare representation approaches, e.g., [28] and [29].

Next, we focus on specific representation approaches and how they relate to generic ones. From the findings it is clear that the ***state machine diagram*** is by far the most popular specific way for game scenario representation. The second is the ***algorithms***, the third is the ***MAP***. The state machine diagrams with diagram are the most common mapping, e.g., [30], followed by state machine diagram with UML, e.g., [31], algorithms with diagrams, e.g., [32] and flowcharts with diagrams, e.g., are both in the third position with eight appearances and in the fourth position is the pseudocode with algorithms, e.g., [33]. In the fifth position is the logic with algorithms, e.g., in the sixth position is the logic with state machine diagrams. Most cases have one or two occurrences, as shown in Figure 3.

Based on the findings one can observe that there are quite many diverse approaches for describing scenarios. For instance, character models are meant to be used for describing characters, i.e., a very specific element of games; whereas state diagrams can describe a large variety of elements in the design: the state of objects, state of characters, etc. Thus, it is interesting to note that in order to describe a game in perfect detail, a lot and very diverse mechanism are required. A similar finding applies to more high-level aspects of game development, where a teams need various skills (developers, 3D artists, texture artists, animators, sound engineers, writers, etc.) and knowledge of various technologies (programming languages, scripting languages, game engines, 3D editors, etc.). In that sense, we believe that it is reasonable to expect that various and diverse ways of representing scenarios will be needed for designing and representing a game.

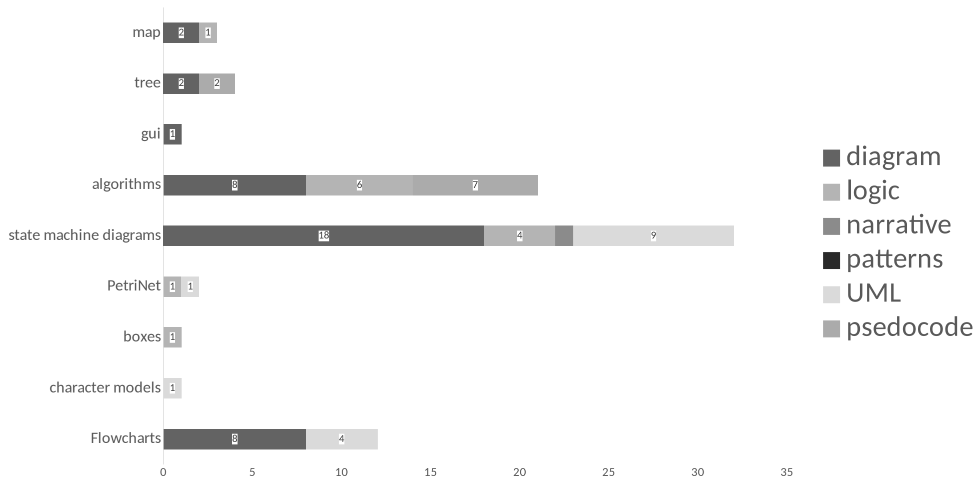

Figure 3. Generic scenario representation approach with specific scenario representation

4.2. Parts of scenario represented (RQ_2)

In Figure 4, we present the mappings of game scenario parts to the generic scenario representation approaches identified in Section 4.1. Game story and game rules are usually represented by diagram [30, 32] followed by narrative, e.g., [34]. Then, game story is presented by UML [14], whereas game rules and game world that are presented by narrative

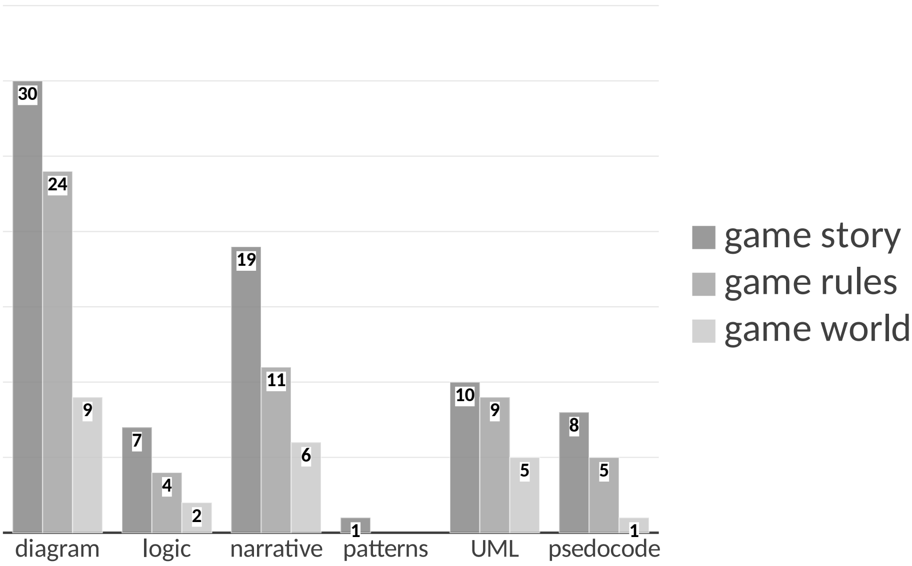

Figure 4. Parts of scenario represented by generic scenario representation approach

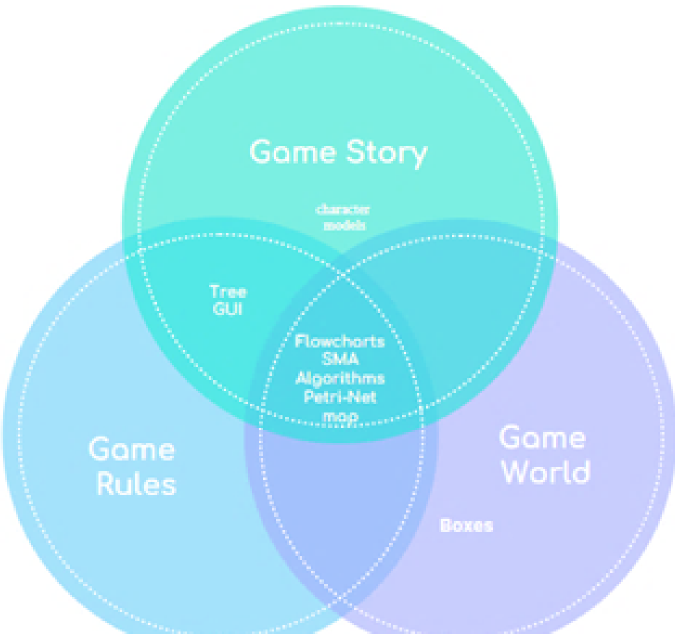

Figure 5. Parts of scenario represented by specific scenario representation approach

approaches. Next, in Figure 5 we present the three parts of game scenario parts, mapped to specific representation approaches through Venn diagrams. From the Venn diagram, we can observe that state machine diagrams, algorithms, flowcharts, Petri Networks and Maps can be used for describing all parts of scenarios (story, world and rules), e.g., [35] Game Story and Game World are not simultaneously described by the same specific scenario representation approach, whereas various combined representations between Story and Rules; and Rules and World can be observed.

4.3. Game representation elements/components and connectors (RQ_3)

In this section we present the main elements of scenarios that are depicted through the identified representation approaches. Following the established software architecture terminology, we divide these elements to components and connectors. ***Components*** are the elements that constitute the scenario as it comes up from the description. Below, we provide a list of the components that we identified in the papers:
- Game state: different situations that the game has, e.g., mini-games [27], phases [36, 37].
- Character state: the different states that the characters have, e.g., behaviors [38].
- Time: as an identifier for best player [39], no answer in a question [40], complete the game.
- Characteristics: color [41], accessible, visible, price [42].
- Dialogues: If they are responses of a player, then they are part of game rules. In this case they determine the evolution of the game.
- Animations: Lights, sound, virtual environment, noise.
- Characters: could be also the enemies.

On the other hand, ***Connectors*** are the elements used in order to join elements:
- *Transitions*: one action from one component could cause an action of another component.
- *Actions*: When a component does something.
- *Sequence*: When events happen one after the other.
- *Controls*: When a button is pressed then one action happens

Table 2. Connectors with generic representation approaches

	Sequences	Choices	Flow	Conditions	Navigation	Actions	Transitions	Controls
Diagram	1	1		2	2	11	27	6
Logic	3			2	1	5	1	1
Narrative	2	1	1			11	9	5
Patterns						1		
UML	2	1	2	1		7	8	1
Pseudocode	1					2	7	1

In Table 2, we present the connectors that are used for each representation approach: with dark grey, we denote the most usual connectors used in a scenario representation approach. Based on the results, when the representation approach is a diagram, the most common connector between components are transitions, followed by actions. These connectors are used also in the narrative and UML representation approaches. Finally, transitions are also used in pseudocode and diagram with controls.

In Table 3, through a heatmap we present the percentage rates of the combination among scenario components and general scenario representation approaches. The dark red cells indicate biggest percentages, whereas white the smallest ones. In the following discussion, we exclude representation approaches with small frequency (e.g., patterns). From the results we can observe that diagrams represent at 18% of the cases characters, 12% objects, and at 10% of the cases locations and goals. Also, narrative descriptions focus on goals, scores, objects, characters, locations, etc.

Table 3. Generic scenario representation approach with components

	Diagram	Logic	Narrative	UML	Pseudocode
Locations	10%	12%	9%	14%	3%
Speed	1%	3%	3%	5%	0%
Object	12%	21%	14%	12%	9%
Characters	18%	9%	16%	17%	14%
Character state	2%	6%	1%	3%	3%
Coals	10%	6%	11%	8%	11%
Dialogues	4%	0%	2%	7%	6%
Answers	5%	0%	1%	0%	3%
Questions	4%	0%	2%	0%	3%
Scenes	2%	3%	1%	3%	3%
Levels	3%	0%	3%	0%	9%
Score	5%	3%	10%	0%	6%
Time	5%	0%	5%	3%	3%
Game state	3%	3%	0%	5%	6%
Decisions	8%	6%	1%	3%	11%
Animations	3%	0%	5%	3%	9%
Move	2%	12%	8%	7%	0%
Characteristic	1%	3%	1%	3%	0%
Events	2%	12%	0%	5%	3%

5. Discussion

Comparison to Related Work: In this section, we discuss the main findings of our work, and complement them with existing evidence from previous literature. First, the need for scenario representation is highlight also Partlan et al. [12], who propose an automated representation of interactive storytelling which consists of four types of relational graphs: (a) the scene graph, which represents how scenes are connected to each other; (b) the layout graph representing the physical placement of the objects in the visual environment; (c) the script graph contains the code to operate the game logic of the scene and (d) the interaction map using static graphical analysis [12]. Second, with respect to the use of flow-charts as an important way of scenario representation, we have found various studies that explain in detail how flow charts can be used in scenario design. For instance, Paschali et al. [14] and Tovinkere and Voss [15] provide tools that are ease to adopt, use, debug and tune. Additionally, the Code City tool was used in another study [16] to visualize cities in games and gives a wide variety of opportunities such as interactivity, extensibility, navigation and completeness. The need of connectors is also emphasized in Fabricatore [17]. Players focus on: (a) what the player can do; and (b) what other entities can do in response to the player's actions (i.e., how the game responds to the player's decisions, this would occur using game mechanics. The importance of interaction through game mechanics was also highlighted in Sedig et al. [18].

Synthesis of Results: The findings of the research questions are synthesized in Figure 6; in which, we present an overview of the approaches of game scenario representation. As in most mapping studies our main outcome is a classification schema. The classification has been built based on the raw data of the mapping study. For readability reasons, while developing the classification schema we preferred not to list the primary studies that should be mapped to each edge. A more detailed representation, in a tabular format is presented in Appendix C. According to Nickerson et al. [43], the most common paradigm for building classification schemas for information systems is the three-level indicators model, which is based on both empirical and deductive approaches [43]. By applying this model, we: (a) examined the objects (i.e., studies), (b) we identified general distinguishing characteristics of the objects, and (c) we grouped their characteristics so as to create our classification schema [43]. Specifically, in step (b) we identified three characteristics that will constitute the three levels of the proposed schema: (a) the 1st level of the schema represents the part of the scenario is depicted; and (b) the 2nd level represents the proposed variables that constitute the three categories of representation method, such as the navigation, the options of a player, the characters, objects, etc.

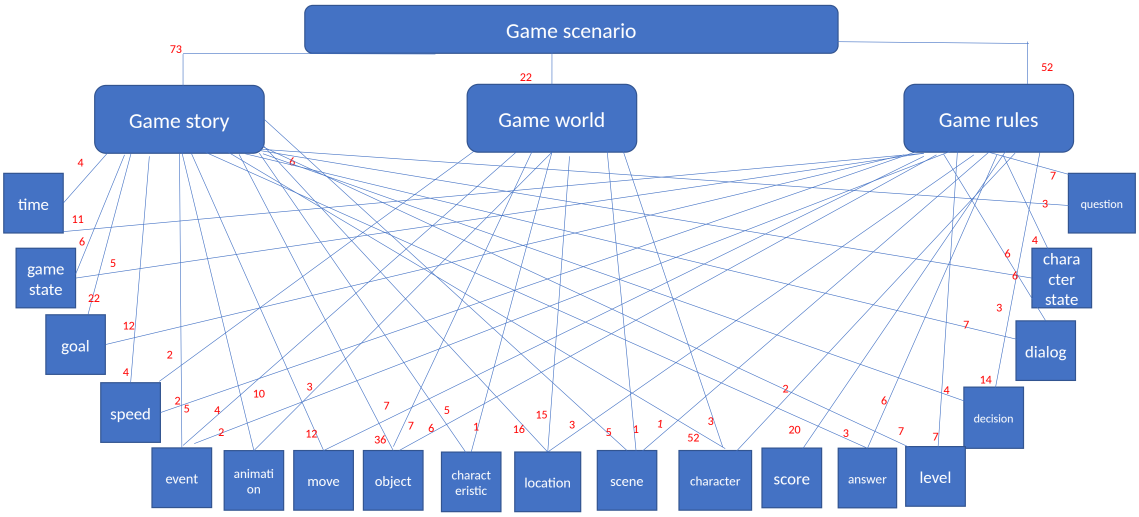

Figure 6. Game scenario representation overview

Implications to Researchers and Practitioners: Based on the classification schema presented in Figure 6, practitioners can: (a) first map the parts of game scenarios to components and connectors, and perform consistency checks – i.e., identify parts of the game scenario that are missing elements descriptions and interactions; (b) second, based on Figure 6, the selected elements can be represented using the most fitting representation approach. In particular, we believe that the following checklist can be used while representing game scenarios to aid practitioners in their scenario design tasks. As a next step, for implementing every item of the checklist, the practitioners can refer to Figure 3 for the most fitting ways of representing each game scenario component. For instance, when the game designer wants to represent game characters (as part of game story), the most frequent means of visualization is through diagrams (4th line of Figure 3); whereas more details can be retrieved from the 52 primary studies mentioned in the last line of the table in Appendix C.

Part A: Have you designed/represented the Game Story?
- Have you explicitly stated the goals of the game?
- Have you explicitly described the objects of the game?
- Have you explicitly described the locations and the levels of the game?
- Have you represented the characters (and their animations) of the game?
- Have you specified the dialogs (Q&As) of the scenes?
- Have you the game state, and the corresponding transitions?

Part B: Have you designed/represented the Game World?
- In the game world, have you specified precise locations?

- Have you mapped locations to game elements (objects, characters)?
- Have you set the locations of scenes and stories?
- Have you set the physics of the world (e.g., speed)?

Part C: Have you designed/represented the Game Rules?
- Have you explicitly specified the rules on when each goal is reached?
- Have you explicitly specified the rules for scoring?
- Have you explicitly specified all the decisions (and possible outcomes) that the user must make?
- Have you guaranteed that the parameters for the rules correspond to game elements (objects, time, characters, moves, levels, dialogues, etc.)?

On the other hand, **researchers** can identify parts of scenario that lack representation approaches, and introduce most fitting ones. Additionally, another interesting future work direction is the provision of tools that not only visualize scenario elements, but also use AI to safeguard the conformance to the aforementioned constraint. Finally, we believe that an interesting future work direction would be the empirical evaluation of the effectiveness and useability of these representation approaches in the game design industry; e.g., organize a workshop that would ask practitioners to represent the same game using different approaches, and later perform focus groups to highlight the pros and cons of each approach.

6. Threats to validity

In this section, we present threats to validity based on the guidelines as supported by Ampatzoglou et al. [44] and [45]. According to Zhou et al. [45] one of the mechanisms of ensuring the level of scientific value in the findings of an SLR is to rigorously assess its validity; in that sense, in this section we identify and report the threats to validity for this study. The classification of threats is performed based on Ampatzoglou et al. [44], since it is a more recent and extensive study.

Study Selection Process: Study selection concerns the first steps of performing the secondary study process, when we had specified the search string to return us the papers related to our subject and filter the most relevant ones for our purposes. To examine the primary studies for inclusion, we had followed a specific protocol based on strict guidelines [46]. The search process has been performed using the search engine of DLs, with specific filters according to our requirements. As the subject is quite general, we had not chosen a broad search string that would lead to an enormous number of papers, so we limited the search space by using quotation marks and searched only the title and the abstract, to focus on more interesting and into the point papers. In addition, we have preferred not to use a very specific search string, dues to risk of missing papers or biasing the results. Although this has led to a rather small inclusion rate (95 out of 710), which however, despite the additional effort in IC/EC process has improved our confidence that a large pool of papers has been screen manually at the full-text level. The next step (inclusion/exclusion) has been completed very carefully, because there is always a possibility of excluding relevant articles. For avoiding this, both authors were involved in this step. Furthermore, from our searching process, we have excluded grey literature and duplicate articles and articles had been written in different language except English. The risk of bias due to missing data, based on SEGRESS [25], has been assessed as low; since: (a) we have faced no limitations with the searching space; (b) we have defined a solid process for setting the search string;

(c) we have compared the results from different DLs for identifying inconsistencies; (d) all well-known papers have been identified; (e) the study selection process was systematic; and (f) we assessed and processed all eligible papers.

Data Validity: Regarding the data validity the main threat is the subjectivity when classifying studies. This step was very time consuming so as to ensure that no mistakes are made. This step has been performed iteratively three times by the first authors, and in between iterations the classification was discussed with the second author. The same mitigation action applies to the construction of the classification schema. In our study the sample size is sufficient, and there is no publication bias since the results come from various communities. The mapping of variables to be extracted and the RQs is straightforward and have been set after a detailed discussion between the authors; the opinion of experts in the field of game design has been consulted for resolving possible terminology issues. We have not assessed the quality of the primary studies, since we have performed a SMS and not an SLR.

Research Validity: Concerning the research validity we believe that our study is reliable, because of the experience in secondary studies of the researchers and the research method is adequate for the goal of this study and no deviations from the guidelines have been performed. The results are sufficiently generalizable since they are based on a large corpus of research items. Finally, we assess the repeatability of our study as sufficient since the dataset is available, and the process is transparently described in Section 3.

7. Conclusions

There is a growing interest in game engineering, which has many differences from classic software engineering. A critical and hard to tackle issue for game developers is how they could represent the game scenario. In the literature, there are several approaches; therefore, a selection of the most suitable one is not an easy task. To alleviate this problem, in this mapping study, we: (a) categorize the scenarios' representation methods in more general categories; (b) create subcategories, when possible, based on the similar characteristics of approaches; (c) present the components and connectors of scenarios that are used in these approaches; and (d) map the part of scenario represented by each approach and component. The diagrams are the most popular way of representing scenarios, followed by algorithms, as subcategory. The objects are the most frequent components of algorithms and transitions are the most popular connectors. We believe that our findings are interesting for both researchers and practitioners in the area of computer game development. Researchers will get useful information for empirically investigating several game engineering aspects. As an example, the difficulty of implementing specific design choices may be investigated. Another example could be researching the impact of scenario design choices on the characteristics of implemented games, e.g., user satisfaction. Practitioners on the other hand, may be informed on the most common scenario design choices and combinations of design elements made before, to decide what approach to take in designing their own scenarios.

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A. List of primary studies

	V1	V2–V5	V6	V7	V8	V9	V10
1	A Metric Suite for Evaluating Interactive Scenarios in Video Games: An Empirical Validation	[14]	UML	flowcharts and character models	goal, game state, events	sequence, choice, flow	game story
2	Hey Peratama: A Breeding Game with Spoken Dialogue interface	[47]	narrative		goal, scene	sequence	game story
3	Natural Language and Inference in a Computer Game	[48]	logic	KL1	object, character, location (colours, accessible)	condition, navigation	game world
4	Development of Information Security Quest Based on Use of Information and Communication Technologies	[49]	narrative		location, object, goal®, character	action	game story, game world, game rules
5	Scenario Analysis Based On Linear Logic	[35]	UML, logic	Petri-Net	location, object, character	action	game story, game world
6	Animating Organizational Patterns	[50]	UML	State machine, diagrams, algorithm	scene®, character	condition, action	game rules, game story
7	Gaming: Back to the Basics	[51]	sketch		location, speed, object	navigation	game world
8	Modelling Parallel State Charts for Multithreaded Multimodal Dialogues	[52]	UML	state chart	scene, dialog, character, location, character state, animation	flow, transition	game story
9	machine translation Effects on Group Interaction: An Intercultural Collaboration Experiment	[53]	narrative		dialog	transition	game story
10	Evaluating Scala, Actors, & Ontologies for Intelligent real time interactive systems	[32]	diagram	algorithm	character, object	condition, action	game story

	V1	V2–V5	V6	V7	V8	V9	V10
11	ExerCube vs. Personal Trainer: Evaluating a Holistic, Immersive, and Adaptive Fitness Game Setup	[54]	narrative		characteristic, object, movement, characters, e®, speed®, level®, animation	transition	game story, game rules
12	Adaptive Mixed-Initiative Dialog Motivates a Game Player to Talk with an NPC	[55]	narrative		dialog, character, question		game story
13	Robust Task-based Control Policies for Physics-based Characters	[56]	pseudocode	algorithm	animation, character state	action, transition, control	game story
14	Creation of Custom-made Serious Games with User-generated Learning Content	[27]	logic	JSON schema	object, score®, level®, game state®	transition	game rules, game story
15	Empathy Up	[57]	narrative		character, score®, object	transition	game rules, game world
16	Effective Team-Driven Multi-Model Motion Tracking	[58]	UML	state machine diagrams, algorithms	object, character, move, goal, location, speed, characteristic	transition	game world, game rules, game story
17	Teaching Boolean Logic through Game Rule Tuning	[59]	logic	algorithm	event, score	action	game rules
18	Educational Virtual Game Scenario Generation for Serious Games	[60]	use case	ATTAC_L, algorithm	character, dialog®, move®, decision®, object	transition, sequence	game story, game rules
19	Playing the "Trust Game" with Robots Social Strategies and Experiences	[31]	UML	state machine diagram	dialog, move, game state	transition, control	game rules
20	Scenario control for (serious) games using self-organizing multi-agent systems	[30]	diagram	Adaptive Multi-Agent System (AMAS)	object, character state	transition	game rules
21	A Serious Game Engine for Interview Simulation: Application to the development of doctor-patient communication	[26]	use case	dialogue model	dialog, object, decision	actions	game rules

	V1	V2–V5	V6	V7	V8	V9	V10
22	Data-driven Dynamic Adaptation Framework for Multi-Agent Training Game	[29]	neural networks	algorithm	event, decision, game state, character state, goal	Adaptation Decision Feature, sequence	game rules
23	Expressing workshop Scenario with Computer Independent Model	[61]	UML	LDL	game state, character,	action	game rules
24	Researches and Development of Interactive Educational Toys for Children	[62]	narrative	algorithm	animation, object	transition	game world
25	An Approach Towards Designing Problem Networks in Serious Games	[63]	graph		goals, location, dialog, object	action, condition, navigation	game rules
26	A Realistic Gamification Attempt for the Ancient Agora of Athens	[64]	diagram	flowchart	answer®, questions®, object	action, sequence	game rules, game world
27	Selected Problems of Designing and Using Deterministic and Stochastic Simulators for Military Trainings	[65]	UML	state machine diagrams	object, event, speed, characteristic	action	game world
28	Activity recognition in a Physical Interactive	[66]	diagram	algorithms	scene	control, transition	game world
29	A flexible framework for mobile based haptic rendering	[67]	logic	algorithms	object, character state, move	action	game story
30	From Learning to Game Mechanics: The Design and the Analysis of a Serious Game for Computer Literacy	[39]	diagram	flowchart	character, level®, score®, goal, answers®, question®, time®	transition	game rules, game story
31	A Data-driven Approach for Online Adaptation of Game Difficulty	[29]	logic		event, decision®	sequence, control	game world, game rules
32	The Robot Tangy Facilitating Trivia Games: A Team based User-Study with Long-Term Care Residents	[40]	diagram	algorithms	score, time, question, answer	transition	game rules
33	Designing game methods of educational systems for maritime specialists advanced training	[68]	pseudocode	algorithms	goal®, character, object, decision®	transition	game rules, game story

	V1	V2–V5	V6	V7	V8	V9	V10
34	Two Player EEG-based Neurofeedback Ball Game for Attention Enhancement	[69]	diagram	GUI	character, object, time®	transition, control	game story, game rules
35	Batch Identification Game Model for Invalid Signatures in Wireless Mobile Networks	[70]	pseudocode, diagram	algorithms	character, dialog®, decision®	transition	game story, game rules
36	The Golden Bullet: A Comparative Study for Target Acquisition, Pointing and Shooting	[34]	narrative		object, move, animation, time	control	game story
37	A Game Theoretic Optimization of RPL for Mobile Internet of Things Applications	[71]	diagram	graph	time®, dialog®, goals®, character, animation, decision®	transition	game story, game rules
38	Multi-Parameter Dynamic Difficulty Game's Scenario Using Box-Muller of Gaussian Distribution	[72]	pseudocode	algorithm	score®, characters, level(gate)®, questions®(problem), answer®	transition	game rules, game story
39	A Methodology for Developing Serious Gaming Stories for Sustainable Manufacturing	[37]	diagram	Algorithm (LCA)	object, goal®, question®, answer®	transition, controls	game story, game rules
40	Serious Gaming for Sustainable Manufacturing: A Requirements Analysis	[73]	diagram	Algorithms (LCA)	goal®, game state®, decision®,	transition	game rules
41	Utilizing virtual worlds for game-based learning: Grafica, a 3D educational game in Second Life	[36]	diagram	algorithms	character, score®, object, location®, question®, answer®, animation(s, time®	transition	game rules, game story
42	Adaptive Virtual Environments a Physiological Feedback HCI System Concept	[74]	narrative		character state,)move	action	game story
43	Measuring Emotional Arousal for Online Applications: Evaluation of Ultra-Short Term Heart Rate Variability Measures	[75]	narrative		animation, object, score®, time®, decision®	action	game rules, game story

	V1	V2–V5	V6	V7	V8	V9	V10
44	Strategy Generation with Cognitive Distance in Two-Player Games	[76]	diagram	algorithms	score®, object, characters, character state®, time®, moves®	transition	game rules, game story
45	A concept map-embedded educational computer game for improving students' learning performance in natural science courses	[41]	diagram	map	goal, object, character, characteristic, character state®, location	action	game story, game rules, game world
46	Monitoring player attention: A non-invasive measurement method applied to serious games	[77]	narrative		object, speed®, character, score®, animation, level®, move, location	control, action	game story, game world, game rules
47	A Game Map Complexity Measure Based on Hamming Distance	[78]	logic	map	move	action	game story
48	Vision-based detection of autonomous vehicles for pursuit-evasion games	[79]	logic	algorithm	scene, move, location, speed, object	action	game story
49	Highly Interactive Scalable Online Worlds	[80]	narrative	algorithm	object, event	transition	game story
50	Designing a BIM-based serious game for fire safety evacuation simulations	[38]	diagram	SHGR	character state, animation, location, object, characters	action	game story
51	Preparing individuals for the demands of PSS work environments through a game-based community approach – design and evaluation of a learning scenario	[81]	diagram	generic model	character, object, event, time	transition	game story
52	World- championship- caliber Scrabble	[82]	narrative	MAVEN	object, score, move, location	action, control	game rules
53	Development of a contextual decision-making game for improving students' learning performance in a health education course	[83]	diagram	storyline tree	decision	action, control	game rules

	V1	V2–V5	V6	V7	V8	V9	V10
54	Transposition of Location-based Games: Using Procedural Content Generation to deploy balanced game maps to multiple locations	[84]	diagram	Weighted Graph Matching Problem	location, character, animation	action	game world
55	ScriptEase: A generative/adaptive programming paradigm for game scripting	[28]	patterns	script erase	game state, dialog, character, character state, object, event	action	game story
56	Pricing models in a sustainable supply chain with capacity constraint *	[42]	diagram	CLSA structure	character, object, decision®, characteristic	transition	game story, game rules
57	Serious Game Approach to Water Distribution System Design and Rehabilitation Problems	[85]	diagram	SeGWADE	location, object	transition	game world
58	For the sustainable performance of the carbon reduction labelling policies under an evolutionary game simulation	[86]	diagram	SD model	game state	transition	game story
59	Testing transformative energy scenarios through causal layered analysis gaming	[87]	diagram	CLA pyramid	game state	transition	game story
60	SCIPS: A serious game using a guidance mechanic to scaffold effective training for cyber security	[88]	diagram	flowchart	score, character, event, decision, goal®	transition	game rules
61	Designing and evaluating the effectiveness of a serious game for safe administration of blood transfusion: A randomized controlled trial	[89]	narrative		character, object	action	game story
62	The design and evaluation of a peripheral device for use with a computer game intended for children with motor disabilities	[90]	diagram	algorithm, flowchart	character, object, move	action	game story
63	Design methodology for educational games based on graphical notations: Designing Urano	[91]	diagram	algorithm	character, scene, dialog, object, location, decision®, score®, goal	transition	game story, game world, game rules

	V1	V2–V5	V6	V7	V8	V9	V10
64	A duopoly game model for pricing and green technology selection under cap-and-trade scheme	[92]	diagram	algorithm	character, object, decision®	action	game story, game rules
65	Fire simulation-based adaptation of Smart Rescue App for serious game: Design, setup and user experience	[93]	UML		character, level, location, goal®	action	game story, game rules, game world
66	An event-driven behaviours trees extension to facilitate non-player multi-agent coordination in video games	[94]	pseudocode	tree	character, event	action, sequence	game story
67	Developing an automated VR cognitive treatment for psychosis: game Change VR therapy	[95]	diagram	algorithm	goal, character, level, location	action	game story
68	A computerized tool to assess reading skills of students with motor impairment	[9]	diagram	flowchart	character, object, goals®, location	transition	game story, game rules
69	Web-Based System for Designing Game-Based Evacuation Drills	[96]	diagram, pseudocode	state machine diagrams, algorithms	scene, goal, decision, animation	transition	game story, game world
70	Evaluation of a 3D serious game for advanced life support retraining	[97]	narrative		character, location, goal	action	game story, game world
71	A Video Game Description Language for Model-based or Interactive Learning	[33]	pseudocode	algorithms	object, level®, location, game state, goal®	transition	game rules, game story
72	A Scenario Editor to Create and Modify Virtual Simulations and Serious Games for Mental Health Education	[98]	diagram	state machine diagram	characters, animations, decision, dialog, game state	transition, choice	game story
73	A Scenario for Collaborative Learning in Virtual Engineering Laboratories	[99]	narrative		character, goal, object®, speed , level®	transition, control, choices	game rules, game story
74	Adaptive Gameplay for Mobile Gaming	[100]	UML	flowchart	object, character, location, time, question®, goal, speed	transition	game story, game rules, game world

	V1	V2–V5	V6	V7	V8	V9	V10
75	Experience in Designing and Developing the Educational Game Block Solver	[101]	diagram	flowchart	character	transition	game story
76	Catch me if you can: A pursuit-evasion game with intelligent agents in the Unity 3D game environment	[102]	logic	algorithms	character, characteristic, object, moves, location	condition	game story
77	Collage – The Carnuntum Scenario	[103]	diagram	flowchart	character, question, answer, location, score®	transition	game story, game rules
78	Design and Development of a Serious Game for the Teaching of Requirements Elicitation and Analysis	[104]	narrative		character, goal, time®, level, score®	transition	game story, game rules
79	Designing a Serious Game: Teaching Developers to Embed Privacy into Software Systems	[105]	diagram	state machine diagram	goal, character, decision	action	game story
80	DEVELOP-FPS: a First-Person Shooter Development Tool for Rule-based Scripts	[106]	diagram	state machine diagram	character, location	control, transition	game story
81	Developing a Serious Game for the Elderly to Do Physical and Cognitive Hybrid Activities	[107]	diagram		goal, answer, character, score®	control, transition	game story, game rules
82	Mobile Learning by the Example of the Carnuntum Scenario	[108]	narrative		character, location, question, answer	transition	game story
83	The Design of MobiGP by Using Tamagotchi	[109]	UML	flowchart	character, goal, time	transition	game story
84	Learn by Playing A serious war game simulation for teaching military ethics	[110]	diagram	map	character, location	transition	game story
85	Work-in-Progress: The Road to Learning, Using Gamification.	[111]	narrative		character, goal, score®, time®, level	action	game rules, game story
86	”Woodlands” – a virtual reality serious game supporting learning of practical road safety skills.	[112]	narrative		character, goal, object, location		game rules, game story, game world

	V1	V2–V5	V6	V7	V8	V9	V10
87	The Design and Implementation of Arrow Game Projection Interactive System Based on Deep Learning	[113]	logic	algorithm	object, goal, location	sequence	game story
88	Serious Games for the Elicitation of Way-finding Behaviours in Emergency Situations	[114]	narrative		goal, location, move, character, level	action, control	game story
89	REAL: Reality-Enhanced Applied Games	[115]	narrative		location, character, score®, goal	transition	game story, game rules
90	RoadEthos: Game-based learning to sensitize children on road safety through ethical reasoning	[116]	narrative		character, goal, object, move®, location	sequence, flow, transition	game story, game rules
91	Game Simulation of Smart Taxis	[117]	UML		character, object, location, move	transition	game story
92	Mobile Serious Game Proposal for Environmental Awareness of Children	[118]	narrative		character, object, goal, score®	action	game story, game rules
93	No Limit: A Down Syndrome Children Educational Game	[119]	narrative		score®, time®, level, object, move,	action	game story, game rules
94	Development of a Semi-Autonomous Robotic System to Assist Children with Autism in Developing Visual Perspective Taking Skills	[120]	diagram	state machine diagrams	event, dialog	transition	game story, game rules
95	An Educational Game for Teaching Search Algorithms	[121]	diagram	flowchart	location, move, decision, level, goal	action	game story, game rules, game world

B. Classification of studies to scenario elements

Game story		
Time	4	[34, 81, 100, 109]
Game state	6	[14, 28, 33, 86, 87, 98]
Goal	22	[14, 39, 41, 47, 58, 91, 95–97, 99, 100, 104, 105, 107, 109, 111, 113–115]
Speed	4	[26, 79, 99, 100]
Event	5	[14, 28, 80, 81, 94]
Animation	10	[34, 36, 38, 52, 54, 56, 71, 75, 77, 98]
Move	12	[34, 67, 74, 77–79, 90, 102, 114, 117, 119, 122]
Object	36	[27, 28, 32–35, 37, 38, 41, 42, 49, 54, 58, 60, 67–69, 75–77, 79–81, 89–92, 100, 102, 112, 113, 116–119, 123]
Characteristic	5	[41, 42, 54, 58, 102]
Location	16	[33, 38, 52, 79, 95, 102, 103, 106, 108, 110, 113–117, 123]
Scene	5	[47, 52, 79, 91, 96]
Score	0	
Answer	3	[103, 107, 108]
Level	7	[93, 95, 104, 111, 114, 119, 121]
Decision	4	[96, 98, 105, 121]
Dialog	7	[28, 52, 53, 55, 91, 98, 120]
Character state	6	[28, 52, 56, 67, 74, 78]
Question	3	[55, 103, 108]
Character	52	[32, 35, 36, 38, 39, 41, 49, 50, 52, 54, 55, 58, 60, 68–72, 76, 77, 81, 84] [42, 89–95, 97–106, 123] [107–112, 114–118]
Game rules		
Time	11	[36, 39, 40, 69, 71, 75, 76, 81, 104, 111, 119]
Game state	5	[27, 29, 31, 61, 73]
Goal	12	[29, 33, 37, 49, 63, 68, 71, 73, 88, 93, 112, 123]
Speed	2	[54, 77]
Event	4	[29, 59, 88, 120]
Animation	0	
Move	7	[26][60] [31, 76, 82, 116, 121]
Object	6	[26, 30, 36, 63, 82, 99]
Characteristic	0	
Location	3	[36, 63, 82]
Scene	1	[50]
Score	20	[27, 36, 39, 40, 57, 59, 72, 75–77, 82, 88, 91, 103, 104, 107, 111, 115, 118, 119]
Answer	6	[36, 37, 39, 40, 64, 72]
Level	7	[27, 33, 39, 54, 72, 77, 99]
Decision	13	[26, 29, 42, 60, 68, 70, 71, 73, 75, 83, 88, 91, 92]
Dialog	6	[26, 31, 60, 63, 70, 71]
Character state	4	[29, 41, 52, 76]
Question	7	[36, 37, 39, 40, 64, 72, 100]
Character	2	[61, 88]
Game World		
Time	0	
Game state	0	
Goal	0	
Speed	2	[51, 65]
Event	2	[29, 65]
Animation	3	[62, 84, 96]
Move	0	
Object	7	[48, 51, 57, 62, 64, 65, 85]

C. Conformance to SEGRESS

SEGRESS item	Discussion
Title	The paper is entitled as a mapping study
Structured abstract	Followed based on journal guidelines
Opening	1st paragraph of introduction
Rationale	2nd paragraph of introduction
Objectives	Section 3.1
Eligibility criteria	Section 3.2
Information sources	Section 3.2
Search strategy	Section 3.2
Selection process	Section 3.2
Data collection process	Section 3.3
Data items	Section 3.3
Study risk of bias assessment	Section 6
Effect measures	Not applicable
Analysis and synthesis methods	Synthesis not applicable, just classification
Reporting bias assessment	Not applicable
Certainty assessment	Not applicable
Study selection	Figure 2
Study characteristics	Section 4
Results of individual studies	Section 4
Results of analyses and synthesis	Section 4
Reporting biases	Section 6
Discussion	Section 5
Registration and protocol	The protocol is presented in Section 3