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Guide to Development of educational games through Product Line: a literature review

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Abstract

Due to Internet, mobile phone, and side discussion distractions, students lose interest in class quickly. This may be a consequence of the present teaching approach, which is predicated on slides. Numerous researchers are incorporating novel teaching strategies that aim to enhance the dynamic nature of classes, including task-based learning, flipped classrooms, and activities. Most educational games (EGs) are modified or expired versions of previous games. This is especially relevant when the instructor has little time to build the game or little experience. Software Product Line (SPL) technique combines systems with comparable capabilities to create similar products. This research demonstrates a literature review to evaluate the benefits, characteristics, time, and effort of building an SPL for EG development. Narrative, feedback, learning progression, educational activities, and reinforcement were among the essential attributes of the SPL that were identified during the course of the investigation. Additionally, the motivation for development illustrated that this activity could decrease the time and cost necessary to create these games, while simultaneously reducing the learning curve of students by utilizing games with comparable structures, images, and narratives. Lastly, the instruments that can facilitate the development of SPL and the efforts necessary to develop them are addressed.

Index Terms—Serious Games, Educational Games, Software Reuse, Product Line, Teaching

I. Introduction

Many students who have only been in class for a few minutes have completely lost interest and focused on the material. This may be attributed to the numerous distractions that surround the student, including smartphones, internet, conversations, being intensified by the current teaching method, which is primarily focused on the teacher and slides, with few strategies that capture the student's attention. Consequently, there is a lack of motivation and engagement during classes [1]. Due to this, educators continue to explore innovative learning methods that integrate education and enjoyment in order to improve student motivation and engagement [1]. Task-based or problem-based learning, gamification, and game-based teaching are among the most prominent forms of active learning methodologies. These methodologies are known to encourage students and play a central role in their learning journey, and numerous studies have demonstrated positive outcomes [2].

Games have the power to alter how players encounter problems, making them invisible to the naked eye and enhancing the engagement and enjoyment of the activity. Players can become involved in the game context for hours, even losing track of time [3]. Video games, in particular, are visual, interactive, practical, and possess features that attract the user's attention, rendering them an exceptional method of entertaining and distracting students while they continue their education [4]. Studies have demonstrated that Educational Games (EGs) enhance the acquisition of knowledge, skills, and perceptions, and foster critical and creative thinking, among other benefits [5].

Although EGs offer numerous benefits in the educational field, they are challenging to design and require a diverse set of skills, as well as technical knowledge and resources, to develop their digital versions [6]. The aforementioned challenges encourage game developers to adapt or recreate previously created games rather than building entirely new games from scratch [7]. This method entails the modification of preexisting software to accommodate a new purpose, this concept is analogous to opportunistic Software Reuse (SR). In the gaming industry this concept can be called mod [8]. This method reduces the experience required for game development, as the ability to alter is dependent on recognizing and adapting existing game mechanisms instead of building the complete game from scratch. Although changes are inevitable, this modification technique significantly reduces the amount of time and money required to produce a game [7].

Software Product Line (SPL) is a subset of SR that can be characterized as a collection of systems that exhibit similar attributes that can be altered through variation points, which allow the addition, removal, or modification of features [9]. The primary objective of SPLs is to decrease software development time and enhance productivity [10]. The examination of major company games can reveal SPL patterns employed in their development [11]; nevertheless, this approach is not commonly applied in the production of EG [12].

The development of a EG is naturally complicated; thus, it is impossible to

expect that a teacher is able to build games for their students. Various tools and approaches designed to enhance this process have been employed, including Scratch, eAdventure, Alice, and Roblox Studio, along with some engines and development methodologies through modifications [13]. Nonetheless, despite the availability of these tools and principles, the construction of EGs can be time-consuming. A literature review was conducted to identify the advantages, characteristics, time, and effort involved in constructing a SPL for the development of educational games. The goal of SPL is to shorten the development time of EGs and to make it easier to create analogous games that utilize similar components and gameplay. This will reduce the learning curve necessary for students to understand the game that teaches similar disciplines.

The remainder of this paper is presented as follows: Section 2 discusses the research method used in the review; Section 3 describes the results found in the review and Section 4 presents the final considerations with the limitations of the work.

II. Research Method

Systematic mapping is a type of secondary study that explores and categorizes studies, providing an overview of a given subject, based on a structured and repeatable process or protocol [14]. This study aggregates information based on primary studies related to a research question.

The goal of this study is to analyze, map, and answer the research questions of the protocol that will be presented, with the characterization of the SPL development area for EGs. The analysis includes papers published to the end of August 2024, containing a 10-year interval.

To formulate the research questions, the 5W2H method (WHAT, WHY, WHERE, WHEN, WHO, HOW, and
HOW MUCH) was employed, as recommended by Carvalho et al [15]. More detail of each of the method's dimensions are demonstrated below [11].

- WHAT: aims to determine the attributes that are associated with the intended audience. This dimension was employed in this mapping to determine the characteristics that are essential for the development of an SPL for EGs;
- WHY: is aimed to comprehend the reasons and benefits for the target audience. In this mapping, the dimension was used to find the reason to create an SPL for EGs;
- WHO: aims to identify the intended audience. The target audience for this mapping is clearly defined as teachers and students who will be utilizing SPL. Nevertheless, this dimension was employed to determine the individuals who are utilizing SPL for the development of EGs.
- WHEN: Its purpose is to identify the scenarios in which this type of research object can be implemented. As part of this mapping, this dimension was used combined with the" why" dimension to identify the best moment and reason for implementing SPL;
- HOW: seeks to determine the proper application of the research object. This

dimension was used in combination with the" what" dimension in this mapping to establish the features that should be included in the line and their proper application;

- HOW MUCH: is related to the development effort of the research object. In this mapping, this dimension was used to determine the SPL development effort for the development of EGs.

It was possible to formulate the search questions that this investigation seeks to resolve subsequent to the introduction of 5W2H:

1) How and what features are used in SPL for the development of EGs? (WHAT and HOW);
2) Why and when should SPL be used in the development of EGs? (WHY and WHEN);
3) Who and what current tools use SPL for the development of EGs? (WHO);
4) How much effort/cost is involved in developing EGs through SPL? (HOW MUCH).

In the same way that the 5W2H method was employed to aid in the formulation of the research questions, the PICOC framework (population, intervention, comparison, outcome, and context)
[16] was employed to aid in the development of the search string. Three of the five components were employed to fragment the string, with the goal of enhancing the effectiveness of the results obtained. Certain terms in the search string were added with the character" *" at the end to allow for the inclusion of any derivative of the original word. A more detailed explanation of each of the PICOC dimensions is provided below [16].

- Population: primary theme of the subject under investigation. This work contains synonyms related to terms associated with" game". It can be compared to the WHO and WHAT components of the 5W2H framework;
- Intervention: supplementary theme of the subject of investigation. This work discusses synonyms related to terms associated with SPL. It can be compared to the HOW aspect of the 5W2H framework;
- Comparison: This dimension facilitates the comparison of one object of study with another. This study did not intend to compare two themes; therefore, it was not utilized;
- Outcome: what the study seeks to find as a result. In this work, they are synonyms that refer to words related to "tools";
- Context: aims to define the search string by including terms that demonstrate the subject's relevance. This work has an educational context; however, when synonyms for this context were inputted into the PICOC dimension, only 12 papers were retrieved. In light of this, it was decided to explicitly incorporate terminology associated with EGs into the population. Nonetheless, because the words "gami*" and "game*" had already been integrated, any synonym including this segment would have been retrieved, and only the term "edutainment" was added to the population.

The found synonyms facilitated the derivation of search strings for each database utilized in the study. The string was constructed by aggregating words of identical PICOC dimensions using the logical operator ”OR” and connecting each dimension with the logical operator ”AND”.

Because the search was limited to 10 years and every review is prone to loss of work, there is no perfect search string. To address these limitations, a snowballing method was employed, involving the examination of references and citations from the papers.

The snowballing process is executed in two forms: forward and backward [17]. The first stage seeks to identify new papers based on works that mentioned the analyzed work, while the second aims to find new papers based on references inside the paper. The paper review process comprised five stages:

1) Execution of the search string;
2) Selection of papers based on titles;
3) Selection of papers based on abstracts;
4) Selection of papers based on full text;
5) Implementation of the snowballing technique, with stages 2 to 4 repeated for the papers identified in this process.

The inclusion criteria are as follows:

1) The paper must pertain to serious games;
2) The paper must present a primary or secondary study;
3) The paper must detail an evidence-based study employing empirical methodologies (e.g., interviews, surveys, case studies, formal experiments, etc.).

The exclusion criteria applied are:

1) Book chapters and calls for papers;
2) Duplicate papers, authored by the same individuals with identical content, wherein the most comprehensive article was chosen;
3) Studies that were not accessible in their full version.

The inclusion and exclusion criteria were assessed at each stage 2, 3, and 4 of the method.

P	Game*, gami*, play*, edutainment
I	Software Product Line, SPL, Software Reuse
C	Unused dimension
O	Tool*, engine*, mechanism*, application*, app*, platform*, instrument*, system*, console
C	Unused dimension
TITLE-ABS-KEY ((game* OR gami* OR play* OR edutainment) AND (" Software Product Line" OR spl OR" Software Reuse") AND (tool* OR engine* OR mechanism* OR application* OR app* OR platform* OR instrument* OR system* OR console)) AND (PUBYEAR ¿ 2014 AND PUBYEAR ¡ 2025) AND (LIMIT-TO (SUBJAREA," COMP") ORLIMIT-TO (SUBJAREA," ENGI"))	

TABLE I: Search String

III. RESULTS

As mentioned in the previous section, the search string was executed in four search databases, namely, Ei Compendex which returned 265 articles, Scopus with 262, Science Direct with 223 and IEEEXplore with 48, totaling 798 articles to be analyzed. In the selection by title, all works that have no relation to the work, book chapters, and invitations for conferences were eliminated, leaving 434 items to be analyzed. The abstracts of all works that did not align with the context of the work were eliminated during the abstract selection process, resulting in a total of 47 works that were eligible for analysis. The papers from the previous stage were thoroughly reviewed and analyzed to determine whether they addressed at least one research question. After this initial filter, 15 papers persisted and were chosen for the study.

After the aforementioned procedure, all remaining papers were applied to the snowballing process. The backward procedure returned a total of 391 papers, with all references to the 15 selected papers being verified. 41 papers were returned through the forward procedure, with all citations to the 15 selected papers being verified. Adding an additional 432 items to be analyzed. The new papers that were selected were subjected to the entire selection process, including title, abstract, and full-text reading. At the conclusion of the entire analysis process, an additional five papers were included, resulting in a total of 20 papers that were selected for the extraction of research information. In total, 1230 papers were analyzed throughout the research.

Each of the selected papers can be viewed in the following Table 2, which

displays the questions to which each papers responds, as represented by columns Q1 through Q4.

From Table 2, it is possible to observe that there are not many works that describe the development of SPL for the development of EGs, with only 20 works. The majority of these works merely designate the characteristics of the tree, but they do not implement them. Furthermore, it is also possible to observe that there have been only three studies on the subject in the past three years. This lack of studies can be attributed to a variety of challenges, including the selection of characteristics and variability, the definition of the domain, and the size of the line [26]. Despite the low number of works found, only 20, the majority of papers in the search string addressed SPL issues in the context of game development without an educational context, indicating the importance of the topic. Then, each research question will be answered with the information that was discovered during the period of the research.

How and what features are used in SPL for the development of EGs?

In order to create a EG, it is essential to comprehend the manner, timing, and characteristics of the game that should be applied to the player, with the goal of establishing a progressive and appropriate learning curve. The correct application of these characteristics assists the students in feeling more relaxed, motivated, and prepared to continue learning while enjoying themselves [27]. Therefore, a series of characteristics must be taken into account, including gender, player count, difficulty progression, rules, victory conditions, score, effort, virtual environment, objective, time, and control, all of which are relevant to the overall development of games. In the educational context, it is possible to identify certain characteristics, such as assessment, exercise, content, feedback, and external references [4]. It is also crucial to know the appropriate time to collect each piece of information and to comprehend the players' emotions and psychological state, which includes everything related to their ability to take initiative, their authority, their commitment, and so forth [27].

Certain works utilize SPL to develop serious games in the cognitive rehabilitation field, focusing on characteristics that enhance memory, attention, and concentration, which are critical topics for the development of EGs. These games can be developed using a variety of platforms, interfaces, and technologies, with a particular emphasis on 2D and 3D interfaces, platforms such as computers, smartphones, and consoles, as well as technologies such as augmented reality,

TABLE II: Papers selected for the study.

Title	Reference	Q1	Q2	Q3	Q4
Lightweight Aspect-Oriented Software Product Lines with Automated Product Derivation	Perdek and Vranic [18]	X	X		
A Multi-engine Aspect-Oriented Language with Modeling Integration for Video Game Design	Geisler and Kavage [19]	X	X		
SATReLO: A tool to support language therapies for children with hearing disabilities using video games	Martínez Arias et al. [20]	X	X	X	
Recovering Software Product Line Architecture of Product Variants Developed with the Clone-and-Own Approach	Lee et al [21]	X	X		
Serious gaming coming of age: Implementing a European innovation policy to amplify serious game development	Westera [22]	X	X		X
What do serious games developers search online? a study of GameDev StackExchange	Tamla et al [23]	X	X		
A Feature-Based Approach to Develop Digital Board Games	Boaventura / Sarinho [24]	X	X	X	
Using Software Product Lines to Support Language Rehabilitation Therapies: An Experience Report	Martinez et al. [25]	X	X	X	
Building educational games from a feature model	Martins et al. [4]	X	X		X
AsKME: A Feature-Based Approach to Develop Multiplatform Quiz Games	Sarinho et al. [26]	X	X	X	
Exploration of software product line to enrich the modeling of mobile serious games	Meftah et al. [27]	X	X	X	
Software product line extraction from variability-rich systems: The robocode case study	Martinez et al. [28]	X		X	X
Creating a software product line of mini-games to support language therapy	Rincon et al. [29]	X	X		
Practices and Technologies in Computer Game Software Engineering	Scacchi [30]	X	X		
JIndie: A Software Product Line for Educational Games with a Focus on Constructionism (In Portuguese)	Lessa Filho and Hernández-Domínguez [31]	X	X	X	X
Introducing computer games and software engineering	Cooper and Scacchi [32]		X	X	
BROAD-PLG: Computational Model for Building Educational Games (In Portuguese)	Martins et al. [33]	X			
Brain points: A growth mindset incentive structure boosts persistence in an educational game	O'Rourke et al. [34]	X	X		
A feature model for health-focused serious games: a software product line-based approach (In Portuguese)	Tavares et al. [35]	X	X		
Cat King's metamorphosis: The reuse of an educational game in a further technical domain	Sobke et al. [36]	X	X		X

virtual reality, or traditional methods such as controls or a keyboard [35]. However, some authors contend that platform, interface, and technology are not essential for the teaching of a particular discipline, with the content of the game being the primary source of concern [37].

Following the same theme of characteristics that enhance memory, attention, and concentration, certain studies investigate the use of educational activities that involve multiple-choice questions. In order to illustrate, this type of activity was employed to teach fractions, in which the player was required to select all sentences that were equivalent to the question [36]. In addition to the academic quiz activity, other authors are also utilizing other activities with basic mechanics to enhance the effort, motivation, concentration, and self-improvement of students. These activities include information correlation, crossword puzzles, organization, and image search [29]. Despite the fact that these activities possess basic mechanics, they are regarded as an excellent method for providing self-assessment. They are repurposed by other game subdomains, serving as activities within a larger game, and being used as activities within teaching tools, such as Moodle [26]. These activities are called educational activities.

The classifications of EGs can be diverse and vary depending on the type of game, with a particular emphasis on action, adventure, construction, simulation, RPG, and so forth, or even a combination of multiple types [32, 35]. There are mechanics and types that are more appropriate for the context depending on the intention of the game to be created. If the objective is to recall previously acquired knowledge, games such as quizzes and matching are more appropriate. If the objective is to encourage students to think and analyze the circumstances, the most appropriate games are puzzle, RPG, and strategy. Simulators or construction games are recommended to stimulate students' creativity. It is important to remember that these types of games are not exclusive in their objectives; in fact, they can be combined to create a new game [38]. Finally, it is recommended that games include a narrative for the player, which is used to facilitate the comprehension of content by individuals without prior experience. Some authors emphasize the importance of explicitly stating the objectives that guide the tasks that the player is performing. One method of elucidating the meaning is through the narrative characteristic, which involves the development of an engaging justification that fosters a connection between the game and the player by recounting the events that transpired [33].

Also, progress tracking techniques were emphasized as effective methods for the development of serious games. These techniques focus on the collection of each play, with the objective of enhancing the game, increasing player engagement, and understanding the player's challenges through the analysis of collected information [23, 35, 34, 19].

The simplified SPL is illustrated in Figure 1, which is accompanied by Table 3, providing a detailed explanation of each characteristic, including its intended use and some considerations.

Why and when should SPL be used in the development of EGs?

The development of games in their digital versions is an even more complex task, being multifaceted and requiring the integration of several fields of computing and technical skills. Most significant software development challenges arise during the development of digital games, including design, requirements, interface, and so forth. This is a costly endeavor that necessitates a significant amount of development time [24]. While this endeavor is discussed, common card or board games highlight the clear prospect of inventing a mechanism or tool that distributes or reuses artifacts to support numerous games [30].

Serious games are often characterized by low budget and are often referred to as “the poor cousins of games” [22]. Rather than developing new games, the majority of EGs designers focus on adapting (modifying) existing ones [7]. This strategy reduces the experience required for game creation, as the ability to modify is based on the recognition/adaptation of game mechanics rather than the creation. These adaptations are inevitable; however, they can significantly reduce the effort and resources required to develop a serious, effective game [7]. These adaptations are necessary due to the significant cost, time, and effort required to construct a game. These costs can be reduced if there are active and pedagogical components that can be repurposed and integrated into the development process. Despite the existence of engines, frameworks, and development packages for game creation, the literature lacks tools to assist in the creation of EGs, as they are only available for game development and lack educational focus [23]. EGs can significantly contribute to the process of recapturing students’ interest [31]. Consequently, it would be optimal for teachers to create their own games. However, it is illogical to assume that a single teacher could independently create games for his/her classroom due to the effort required for game development, the absence of EG tools, and the limited time a teacher has to teach, correct work, and administer exams [36, 21].

In general, serious games require the characteristics that were mentioned in Table 3, with many of them being similar to any type of game that is to be created. Considering all that has been previously mentioned, applications that belong to the same market segment and possess a significant number of common characteristics can be developed using an SPL. This is the primary motivation for creating an SPL for the development of educational games [35, 31, 18]. In summary, an SPL enables the efficient management of a set of products that belong to a specific domain and possess common and variable elements, which can be edited through the use of variation points.

The primary benefits of this approach include the reduction of time and costs associated with the development of an application, as well as the enhancement of quality [4].

Another reason for the use of SPL in the development of games is the construction of franchises. For instance, numerous successful games were

converted into franchises through the development of an SPL, with a particular emphasis on Quake, Quake II, and Quake III, as well as Unreal and all editions of Unreal Tournament [32, 18]. In the same way, it is possible to consider the use of this franchise strategy to construct EGs. In order for a game to teach something, the player must first learn the game's functionality before beginning to learn the content being taught. Consequently, there are two learning curves: one for the game's functionality and another for the content that is intended to be taught through the game. In order to reduce the learning curve of the game and allow the student to concentrate just on the material being taught, EGs franchises can be established through the use of SPL. This allows for the teaching of subjects within the same discipline through games that share the same characteristics, sprites (images used in the game), characters, histories, and contexts. Consequently, all games that teach, for example, algebra, would employ similar games, presenting only the content to be learned.

Who and what current tools use SPL for the development of EGs?

For digital games that put first entertainment, it is feasible to locate SPL in prominent franchises, including Quake, Quake II, and Quake III; Unreal and all editions of Unreal Tournament [32]. Additionally, engines, frameworks, and development kits are accessible to facilitate game development. However, only three SPLs were actually developed, and there were not many tools for the development of EGs through SPL in the review. In general, the majority of the works that were identified only discussed the modeling of SPL, without demonstrating its development or the tools necessary to use the line. The literature has specifically highlighted the lack of tools to support the creation of serious games [23].

The initial SPL discovered is a simple tool that is designed for the development of educational questionnaire activities, allowing for the selection of different platforms for game execution, such as a console, mobile device, and computer [26]. The second SPL discovered was for cognitive rehabilitation, focusing on characteristics that enhance memory, attention, and concentration, all of which are critical for the development of EGs. This SPL, known as SATReLO, also employs educational activities, such as dominoes to enhance comprehension of patterns, object organization and search activities to enhance observation and comparison, and image sequencing activities to enhance interpretation and activity progression. Furthermore, the tool records all of the player's scoring activities and accomplishments in order to later analyze them [20].

Another SPL that was discovered was not entirely automated; rather, it required coding by the user who wished to create. This SPL had a set of components that the user could edit, thereby facilitating the game's development and reducing the time and cost of implementation. However, the paper demonstrates that three games were developed from the SPL, known as JIndie, with inspiration from existing EGs. For instance, the original game inspiration has 6.937 lines of code in the repository, while the SPL version has 20.210 lines,

out of which only 1.849 were implemented by the developer [31]. Even though code lines are not an ideal metric for software comparison, the paper has chosen this metric. Nevertheless, it is feasible to observe a substantial reduction in the number of lines. However, it is important to note that the tool was not automated and required a technical understanding of the PHP programming language to develop the game. Consequently, the teacher was required to learn this language and allocate a significant amount of time to the development process.

Throughout the investigation, nonconventional SPLs were also discovered, with the first one being constructed through reverse engineering of the bot source codes found in the version repository of the GitHub for the educational robocode game [28]. The objective of this game is to command a tank in battle to destroy one's opponent, with the bot's commands being developed in Java. Another unusual technique was the creation of the game Cat King, which was characterized by the reuse of a game designed with objectives to assist in the memory of basic legal knowledge; however, the game was designed to teach environmental engineering [36].

Finally, tools were also discovered that may assist in the development of SPL, but they do not directly address the subject. One of them addresses progress tracking techniques, which were identified as crucial for the effective development of serious games. Game Analytics is one of the tools that has been identified with this purpose. It is focused on the collection of user interactions throughout the game, with the aim of increasing user engagement. In addition, AI techniques were employed to monitor the player's progress; however, no specific instrument was provided [23, 35]. In addition to the notion of tools to facilitate the construction of the line, the Moodle tool was also discovered during the research, with a particular emphasis on the educational activities that are available [4]. These activities include quizzes, organization, matching, memory games, and more [39, 40].

How much effort/cost is involved in developing EGs through SPL?

The dearth of knowledge exchange on networks may be a contributing factor to the costly and time-consuming nature of game development, which often results in amateur developers "reinventing the wheel," a process that is inefficient [22]. In order to attain widespread market acceptance, it is necessary to reduce development costs and time to market. This can be accomplished by enhancing software reuse and knowledge exchange [22]. Furthermore, three aspects of EGs restrict their development: the necessity for numerous resources, as they incorporate audio, image, animation, and story artifacts, in addition to the complexity of software development; the challenge of ensuring that the content to be taught is transparent; and the rapid degradation of technical and technological capabilities [4].

As previously mentioned, one of the primary advantages of SPL is the reduction of the time and cost associated with the development of similar software [9]. As a result, the time required to develop a game following the construction of

an SPL is significantly reduced, in addition to enhancing its quality [4]). However, the development of an SPL, whether from the ground up or through the reengineering of existing variants, is typically a multi-year project that requires a significant investment.

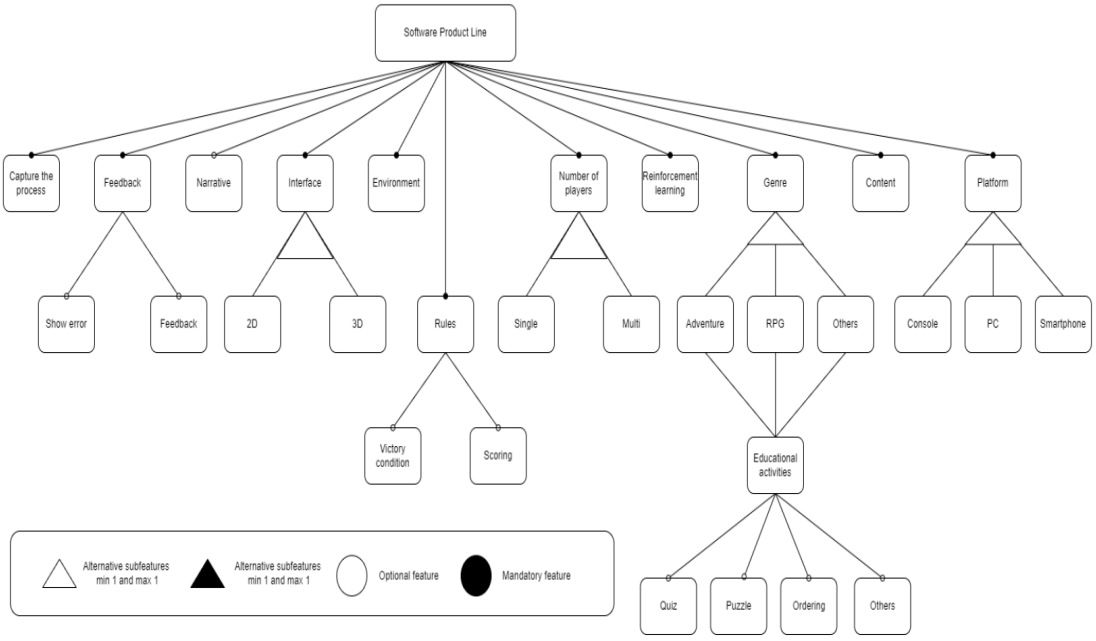


Fig. 1: SPL for EGs.

TABLE III: Characteristics of EGs

Characteristics	Considerations
Genre	Aims to define the game in accordance with its gameplay style. Despite the existence of a variety of games and recommendations for each educational objective, the creation of an SPL that includes all of these types is practically impossible due to the sheer number of mechanics that the line would have to consider. As a result, it is advised that it be created for a single type.
Number of players	Establish the maximum number of players that the game allows. Multiplayer can enhance teamwork inEGs. However, interactions must be implemented twice in an SPL: once for single-player and again for multiplayer.
Rules	Determine the game's functionality and the manner in which players should interact with the game environment, thereby guiding the learning experience and the educational objective. It is necessary to assess each game characteristic and generalize the rules in order to enable their use in the various games that are to be created composing the SPL rules.
Victory condition	Conditions that must be satisfied in order to win a specific game. It is necessary to ensure that the player has assimilated the knowledge that the game is trying to transmit.
Scoring	Players' performance metrics. Reward the student who is acquiring knowledge along the game. The point value may be selected or not in an SPL; however, it is recommended that it be selected to increase the student's motivation.
Environment	Establish the environment in which the player will be immersed. In an EG, the player must first learn the game in order to subsequently learn the material being taught. Therefore, while it is feasible to exchange environments in the SPL, it is recommended to use the same environment for games that teach concepts that are within the same discipline, with the intention of reducing the learning curve of the game.
Goal	Establish the game's objective. The objective of an EG is to instruct on a specific discipline. Consequently, this objective is established based on the game's characteristics and the content that has been incorporated.
Platform	The new engines already enable the creation of builds for various platforms, such as cell phones,computers, and consoles, thereby simplifying the game's implementation. However, it is still necessary to exercise caution regarding the size of the images selected for the game. For an EG, the mobile version facilitates mobility; however, it is recommended that you use computers for larger games.
Technology and interface	Define the technology that will be employed in the game. The technology used in EGs has the potential to alter the way information is presented by incorporating 2D, 3D, and augmented reality objects, thereby increasing the player's motivation. However, it is recommended that only one technology be used to construct an SPL, as the forms of interaction are complex and vary depending on the technology.However, as an illustration, the 2D and 3D interfaces were incorporated into the image, while the form of technologies such as virtual reality were omitted and augmented due to the difficulty of implementing them in a single SPL.
Learning progression	It is essential for an EG to be effective in order for learning to progress. However, the burden of the professor and the material he/she includes is on the SPL. Again, this characteristic is not present in theSPL image.
Progression tracking	Determine the method of data collection for the game. This monitoring is employed in EGs to assess the student's learning progress and comprehend the actions that were taken throughout the game. This feature is not affected by SPL; it is only necessary to employ a technique to accumulate the information.
Educational activities	These are basic mechanical exercises and evaluations that are regarded as an excellent method of self-assessment, and they are employed in EGs and tools such as Moodle. Examples include matching,sorting, image search, and quizzes.
Content	There is no value in an EG that lacks a suitable content for teaching. However, these characteristics are the responsibility of the teacher, who must select the appropriate material for the game.
Feedback	In order for learning to occur, it is necessary that the student comprehends all of the errors that occurred during the game and to demonstrate them in the appropriate manner. This method of error presentation occurs through feedback mechanics, which can be implemented in a variety of ways, including: the removal of points, damage to the player, the demonstration of the correct response, or even an explanation of the response.
Reinforcement	By presenting new activities in the game, it is possible to reinforce the knowledge gained from the students' errors, thereby establishing reinforcement learning.
Narrative	In order to gain a comprehensive understanding of the game and the discipline being taught, it is essential to have a narrative that unfolds, creating a progressive environment for the information that is presented.These narratives must be relevant to the subject matter being taught, and it is the responsibility of the teacher to develop a motivating narrative

This process involves the collection of product characteristics, the selection of similarities, the definition of variation points, the coding of the tree, and other activities [28, 25]. To illustrate the magnitude of the effort, a game that was developed using reverse engineering to create a game with simple mechanics and assessment activities accumulated a total of 1000 hours of effort [36].

In general, there were few comments regarding the time and cost of developing an SPL for EGs, which may be directly linked to the difficulty of analyzing and quantifying the investment in this activity [28, 25] and the low number of SPLs found due to the development difficulty [23].

IV. CONCLUSION

The objective of the study was to conduct a literature review in order to address four research questions regarding the development of educational games employing SPL. The information collected was used to determine the important features for building this SPL, the logic behind its development, the current tools that can assist in the development of this activity, and the amount of effort required to develop it.

The research findings indicate that the development of such an SPL might significantly reduce the time and financial resources needed for game production. Furthermore, it may reduce the learning curve for students by promoting the utilization of games with analogous structures, images, and narratives. The study also examined the resources that can facilitate this development and the extent of effort required to implement the proposed SPL.

Based on the collected data, it was possible to outline the essential properties necessary in SPLs for EGs. These characteristics include, among others, learning progression, educational activities, narrative, feedback, and reinforcement learning. This discovery enabled the formulation of a conceptual SPL model for the creation of instructive games. This model includes all the critical features required for developing games that markedly enhance learning results.

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