Approaches for Serious Game Design: A Systematic Literature Review

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***Abstract*— In this review, the authors analyzed the main features of the design of serious games that promote learning in an academic setting. The purpose of this study is to establish the approaches described in the literature, regarding the methodologies, frameworks, and models applied to game designs, and highlight phases of game development software that improves the learning processes that go hand in hand with the learning objectives. The result of this work identifies 51 potential studies, within the period: 2008-2016, using various well-known digital libraries. The analysis of the selected documents applying the inclusion criteria resulted in 11 approaches that are used for the design of serious games. Additionally, it was possible to identify 31 stages proposed in the documents for the development of the educational game, as well as pedagogical aspects related to learning strategies and educational theories and several key factors that influence the design of serious games.**

***Index Terms*—serious game approach, game-based learning, serious game phases, systematic review.**

I. Introduction

At the beginning, games were created as rule-based systems that attracted players, with the primary purpose of entertainment. But with the successful growth of digital games, new designs are emerging with a developmental approach that supports education. In this perspective, there are Serious Games (SG) that focus on solving challenges created with quantifiable results, which are designed in various ways, with the purpose of supporting education, concerning the learning and instruction axes [1]. With technological advancement, the massive increase of mobile devices and game consoles at homes, schoolchildren spend more time on game-related activities [2], which is a necessity for new forms of education and training to be supported by the metaphor of games, or gamification of learning in different contexts. Now, some researchers have developed SG applied in several areas of science. However, only a few methodologies, frameworks and models have been proposed to guide the design and development of such games [3]. In the SG design, much of the deficiencies can be attributed to the lack of a methodology that relates the game to the educational content and pedagogical aspects [4, 5]. Some papers have only focused on establishing a set of general recommendations, which have a limited contribution to the analysis of pedagogical elements [4]. As there are limited proposals to guide the SG design process [3], these increase barriers that prevent high-quality educational games [6].

The complexity of serious gaming software has established several approaches that involve various activities (storyboarding, analysis, design, animation refinement, video production, scenarios, sound, technological and functional requirements, programming, testing, and evaluation). This diversity leads to an analysis of the perspectives on theory and design methodologies [7]. SG design has gained interest among the researchers. Their studies have reported advantages, through benefits and efficacy, improving motivation in students, immersive learning experiences, engagement, and collaboration in a meaningful learning setting. But there is still a gap between SG designers and developments that have not taken into account some pedagogical and psychological concepts to different learning environments. In fact, SG teamwork must include designers, developers, teachers, psychologists, pedagogues, and students. Together define the specific roles that integrate educational innovation to address problems in this field (which combines game episodes in a synergy as blended learning) that allows creating SG useful.

A few articles were also found that perform literature reviews with related themes [7-10]. In a study conducted by Connolly *et al.* [9] analyzed the software engineering lifecycle process for the development of computational games. Their researchers determined the positive impacts of the application of games on learning and concluded that good results are obtained in the cognitive, behavioral, affective and motivational aspects in a school environment. However, it is essential to define an appropriate strategy for the evaluation of the game. In another approach, Abdul & Felicia [8] investigated the motivational, interactive, fun and multimedia elements of the game that promotes commitment and directly influence the motivation and learning of the students. For this, they proposed a set of recommendations for an adequate design for game-based learning. Considering this principle, the active contribution of the researchers is essential for the design of SG, since it relates

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characteristics and elements, with a didactic approach that must be intertwined in the phases established for the creation of an adequate SG. Another contribution defined by O'Hagan *et al.* [10] found several process models that describe the best practices for game development. They extend the traditional techniques of software engineering requirement using hybrid and agile approaches.

This systematic literature review is the first step towards identifying the research gaps in approaches to the SG design field. The rest of the paper is organized into three sections. Section 2 describes the research methodology used for the design of SG. In Section 3, provides discussions and conclusions.

II. Research Methodology

In this study, the general guidelines proposed by Kitchenham & Carters [11] adapted for SLR, which allowed to collects empirical evidence about formulated research questions. To research this process, the authors have used the light version of the review guidelines that consists of three main phases: Planning the review, Conducting the review and Analysis. These are detailed below.

To formulate research questions that allows gathering and analyzing data. Some terminologies were defined to avoid ambiguity. In this sense, the term Approaches relates to methodologies, framework, and models for the SG design. Meanwhile, Factors refers to elements or causes that act together with others, and that allows a result to be achieved [12]. Also, Pedagogical aspects consider the systematized set of knowledge, which seeks to improve the educational practice, to promote learning, by proposing rules of action, from which the object of study can be observed [13]. Finally, Phases and stages are successive or consecutive states presenting a thing that modifies, changes, or develops.

A. *Planning the review*

The purpose of this paper is to offer a review of literature that focuses on approaches used in SG design with a particular emphasis on phases/stages, pedagogical aspects, and factors. Researchers agree that SG can be a powerful tool. Therefore, it is necessary to examine the characteristics of the game (the game learning goal, educational theory, and pedagogical role of SG) and the cognitive and affective outcomes. With this background, the general research question is carried out, what are the aspects considered in the approaches for serious games design? To answer this question, four secondary questions were raised. More specifically, this study addresses the following issues:

RQ1: What are the approaches used to create serious game software?

RQ2: What are phases/stages that allow serious games to be developed?

RQ3: What are the pedagogical aspects considered in the design of serious games?

RQ4: What factors affect the design of serious games?

Electronic databases were used, which included areas associated with Sciences such as Education & Computing, Engineering & Technology, and Psychology. They were identified as sources of information: journals, conferences, and proceedings. The databases reviewed were: Science Direct Elsevier, IEEE eXplorer Digital Library, Springer, ACM Digital Library, DOAJ, SAGE Journals, Taylor & Francis, Proquest, and PsycINFO. In the search process, an initial selection screened the works published between January 2008 and December 2016. The search strategy was implemented based on four aspects: (a) serious games, (b) educational games, (c) games based on learning, and (d) computer games relating to ("design" OR "methodology" OR "frameworks" OR "model"). To refine the selection of the works, the inclusion and exclusion criteria were applied, and a general review of the title, as well as abstract and conclusions of each article (Table I).

TABLE I
SELECTION CRITERIA

SELECTION CRITERIA	EXCLUSION CRITERIA
Papers that detail methodologies, models, frameworks and design of serious games.	Articles published on company Web sites.
Approaches that detail phases, stages or processes of development of serious games.	Articles that mention serious game design but do not define their stages or phases.
Game-based learning.	Simulation models for serious games.
Articles relevant to the research questions.	Thesis, books, posters, and publishers.

B. *Conducting the review*

In this phase, it was established the selection of articles based on the Inclusion and Exclusion Criteria. The analysis of the contents of the selected documents was carried out, which allowed the determination of their relevance and contribution, according to research questions that were raised. As a result of the search, 1515 papers were identified of which 51 were selected because they met the criteria related to the approaches for SG design (see Figure 1).

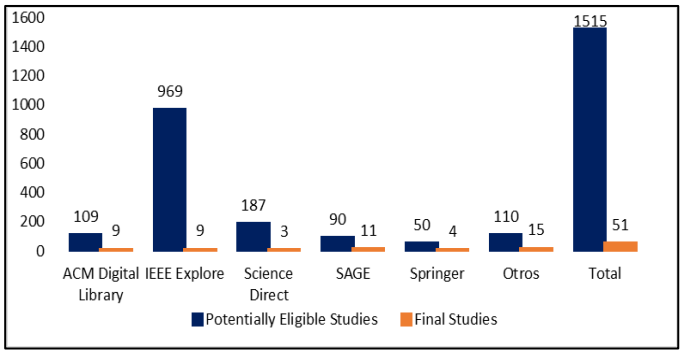

Fig. 1. Selected paper in the electronic database.

Figure 2 shows the trend of publications; the histogram indicates that between 2014 and 2015 there has been an increase in articles related to the topic of approaches for the design of SG. Also, it is evident that the first work related to these aspects was presented by Nadolsky *et al.* [14]. They proposed a

methodology called EMERGO and a toolkit for the development of SG, which promotes the acquisition of sophisticated cognitive abilities in schoolchildren. This method was applied through five case studies with positive results, in aspects of motivation, satisfaction, and interactivity with the proposed game.

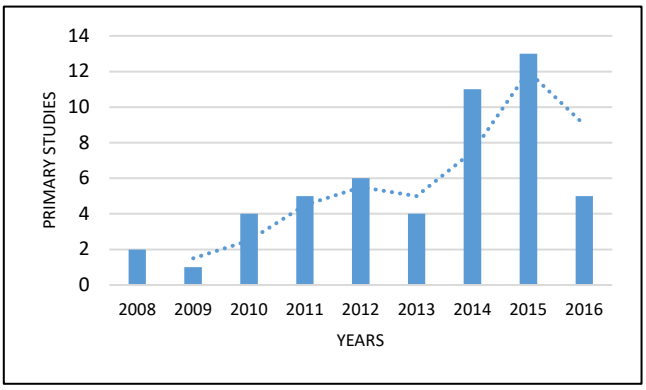

Fig. 2. Research activity on approaches applied to serious games.

The results of the search established that a more significant number of publications in Journal had been found in the database of SAGE. While that In Proceedings, the higher source was ACM. Also, in the Others category corresponding to information sources of Taylor & Francis Group, DOAJ, Proquest, Wiley Online Library & APA Journal, correspond to approximately 63% of scientific production. These results are shown in Figure 3.

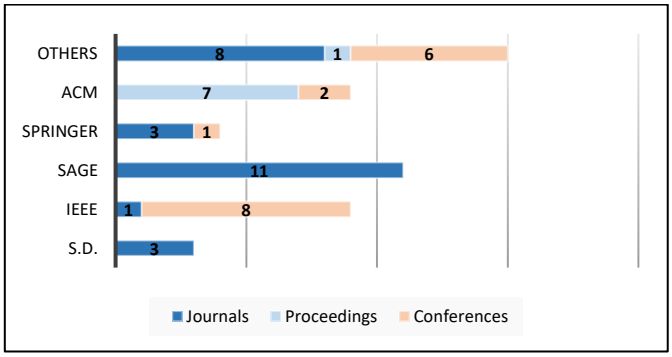

Fig. 3. Publications on serious games design by information sources.

C. Analysis

From the documents analyzed in this paper, the authors proceeded to answer the four research questions aimed at determining approaches, phases and stages, pedagogical aspects and factors for SG design. Table II, details the classification of the researchers found, based on the databases used according to the elements defined above.

RQ1: What are the approaches used for serious game design software?

Several approaches have been used to improve the knowledge of the creation process in the SG design. These raise principles that allow developers to create a flexible, dynamic and easy-to-use system. The approaches used for SG design are presented in Table III.

The authors identified seven methodologies –three frameworks and one model– that are applied to the design of SG, which corresponds to approximately 22% of the total revised scientific production. Of the approaches analyzed, five studies (45%) consider pedagogical aspects, whereas, two papers (18%) focus on therapeutic elements, and four studies (36%) use experimentation processes to validate their proposals, either through the generation of game prototypes or case studies. For the implementation of SG, three authors (28%) use the software engineering lifecycle, and only one paper raises and applies evaluation metrics.

In [4, 15, 16] it was considered software engineering lifecycle stages for the development of SG, and integrated fundamentals of quality assurance. On the other hand, the proposed methodologies focus on the educational field and were developed to create motivational learning experiences that enable knowledge and skills in children and adolescents.

TABLE II
ASPECTS OF SEROUS GAMES DESIGY BY INFORMATION SOURCES

Source	Approach	Pedagogical aspects	Phases and stages	Factors
Science Direct	[5],[17]	[17]	[18],[5],[17]	[18],[5], [17]
IEEE	[4],[19]	[20],[4],[21], [6],[19],[22]	[20],[23],[24], [4],[6],[19], [22]	[25],[20], [4], [6],[19], [22]
Springer	[26]	[27]	[26]	[28],[26], [29], [30],[27]
SAGE	[31],[32], [15],[14], [3]	[33],[34], [35]	[31],[32],[36], [35],[37],[15], [14],[3]	[38],[33], [31], [35],[15], [14], [3]
ACM	[16]	[39]	[40],[41],[42], [16, 43],[44]	[45],[42], [46], [16]
Others		[47]	[47],[48],[49], [50],[51],[52], [53],[54],[55], [56],[57]	[58],[47], [48], [49],[50], [59], [51],[60]

Other authors proposed tools that support the developers to identify aspects of the user and evaluate the characteristics of the game, depending on the skills of the children. The development of experimental processes has not been proven in the analyzed scientific production, which allows validating the theoretical constructs raised by the researchers [3, 4, 15].

RQ2: What are phases/stages that allow serious games to be developed?

The classification of the phases or stages that allow the development of an SG was performed, only considering the four main stages of the software development presented in RETAIN Model [16], which consists of analysis, design, development, and evaluation.

TABLE III
APPROACHES SEARCH RESULTS FOR SERIOUS GAME DESIGN

ID	Purpose	Type	Ref.
E01	MECONESIS: A methodology for SG design for hearing-impaired children, including actors, a context of use, user profiles and game mechanics using an HCI aspects.	Methodology	[4]
E02	A framework that combines game design, learning content modeling and pedagogy with a multimodal perspective.	Framework	[19]
E03	It defines aspects in the design of a learning Role-Play game through a methodology and tools based on actors, rules, and functions.	Methodology	[31]
E04	It describes the development of a gamification services framework, details the development process through the methodology ADR (Action Design Research), and focuses on game design and service design. It also describes an application implemented through the proposed framework.	Framework	[32]
E05	GAMED: A methodology for the development of educational games, which consists of a set of methods, rules, and postulates that are embedded within a software lifecycle. Moreover, it details principles, strategies, and procedures that guide step-by-step the development of projects, reducing the risk of failure.	Methodology	[15]
E06	A methodology based on graphic notation and interactive narrative, which integrates the transversal aspects and handling a set of visual representations that facilitate communication between the members of the team for the development of a serious game, which includes the expected emotional reactions.	Methodology	[5]
E07	It proposes a process of game development, based on traditional paradigms of software engineering and is complemented with digital learning resources based on pedagogical elements that facilitate the teaching-learning process in students.	Framework	[16]
E08	A methodology for SG design based on Cognitive-behavior techniques, with a psychological approach that allows students to experience different feelings and emotions while having fun playing.	Methodology	[26]
E09	ATMSG: A conceptual model that supports a detailed and systematic representation of educational games based on pedagogical objectives using Activity Theory. It allows describing the way those game elements interrelate with others through the gameplay, to achieve the goals set.	Model	[17]
E10	EMERGO: Provides a methodology and toolkits for the development of SG to enhance the cognitive skills of secondary school students. It adapts approaches of ADDIE (Analysis, Design, Development, Implementation, and Evaluation) and well-known for its implementation.	Methodology	[14]
E11	Design and development methodology for SG that facilitates the integration of educational content using the method of problem-based learning. It proposes a development of the game dividing it by several levels and each level contains detailed learning mechanisms for each activity or a mission that the player must execute to get the goal proposed.	Methodology	[3]

As a result, 31 integrated stages were achieved, including simplicity regarding device usage, a collaboration between designers, and participation in the game theme. Furthermore, it was possible to identify that approximately four studies (37%) correspond to the approaches and are applied between four and five stages. The phases mentioned above are presented in Table IV.

The analysis phase comprises the study of the requirements, taking into account the scenarios, pedagogical aspects, learning contents and playful [4]. This process determines a set of stages whose primary objective is to identify the different elements of the production of the SG. The review of literature allowed to recognize ten stages corresponding to approximately 31% of the total identified characteristics. The identification of the problem to be solved with the game and the pedagogical objectives are the characteristics most frequently stated by the researchers. In [3, 17, 26] it was considered this phase to be a systemic aspect, which encompasses the requirements of the game, based on the needs of the players. While the less successive stages are quality assurance, instructional activities, and therapeutic techniques.

In the design phase, digital resources necessary for the creation of the SG must be created, including 2D and 3D illustrations, structured objects, sounds and music that reflect the architecture specifications [16]. Klapztein *et al.* [32] defined the interrelation between educational content and training. This approach emphasizes the relationship of the educational objectives and the challenges of the game, which are developed implicitly. Another study reported the importance of establishing the interactivity of the narrative, through the organization of the game in a collaborative environment, which defines the rules and mechanisms of cooperation between players [5].

According to Mariais *et al.* [31] established that design phase should integrate three elements for the game system. Syntax, which describes the organizational structure of the game elements; semantics, that details the content and interpretation of the aspects of the system, and the pragmatics, that defines the main points for the gameplay scheme. In general, in this phase, ten stages were identified (36% of total), with more frequent

use of narratives, game mechanisms, and architecture. Whereas risk analysis.

The development phase describes the requirement for tools and software resources to create the SG [14]. Moreover, Qingtang *et al.* [25] determined that the platform, software, and tools that consolidate the interfaces of the game allow interactive learning, fun, and an easy to use style. Also, Aslan *et al.* [15] defined the importance of determining a high-level programming language appropriate to the requirements of the programmer and the specification of the game engine. All this, under an integrated development environment, using the best programming practices. Likewise, in this phase, five stages were identified (17% of total) contemplate the elements of programming, based on the requirements raised in the analysis and design phase. It is established that game programming, application prototype, and game integration was more frequently cited by researchers. In contrast, to the quality assurance stage that was only mentioned by one author.

The SG evaluation phase is complemented by two roles: the end user and the expert, which consolidate the different aspects that were developed in the previous steps. In this process, five less considered were quality assurance, evaluation design, and stages were identified (21% of total). The most common were goal validation, feedback, and testing and these correspond to about 34% of the characteristics considered in this phase.

RQ3: What are the pedagogical aspects considered in the design of serious games?

In this question, 11 general pedagogical aspects related to the design of SG were identified, that allows the integration of the software engineering lifecycle with the educational elements, aiming to improve the mechanics of learning, development of skills and students' abilities (Table V). The analyzed articles identified two aspects related to the educational field: pedagogical strategies and learning theories that correspond approximately to 36% and 64% respectively. The pedagogical strategies refer to a general teaching method, and it defines the objectives to be achieved with the creation of the game in a scenario that adapts to the students' needs [4]. While learning theories area conceptual frameworks that explains and predicts how humans learn [61]. The authors considered that a student creates knowledge through the learning by doing paradigm.

TABLE IV
PHASE/STAGES OF THE APPROACHES FORSERIOUS GAME DESIGN

Phases	Stages	E01	E02	E03	E04	E05	E06	E07	E08	E09	E10	E11
Analysis	Identification of the problem	–	√	√	√	√	–	–	√	√	√	√
	Teaching Objectives	√	√	√	√	√	√	√	√	√	√	–
	Teaching Competence	–	–	–	–	–	–	√	–	–	–	–
	Learning Tools	–	–	–	–	–	–	–	–	√	–	√
	User / Player Profile	√	–	–	√	√	√	–	–	√	√	–
	User Experience	√	√	–	–	–	–	√	–	–	√	–
	Quality assurance	–	–	–	–	√	–	–	–	–	–	–
	Specification document	√	–	–	–	√	–	–	–	–	–	–
	Therapeutic techniques	–	–	–	–	–	–	–	√	–	–	–
	Instructional activities	–	–	–	–	–	–	–	–	√	–	–
Design	Patterns Design	√	–	–	–	–	–	–	–	–	–	–
	Narrative	√	–	–	√	√	√	√	√	√	√	√
	Game Mechanisms	√	√	√	√	√	√	–	√	–	√	√
	Requirements Specification	–	√	–	–	√	–	–	–	–	√	√
	Architecture	–	–	√	–	√	–	√	√	√	–	–
	Design Prototype	√	–		–	√	–	–	–	–	–	–
	Quality assurance	–	–	–	–	√	–	–	–	–	–	–
	Document Specification	√	–	–	–	–	–	√	–	–	√	–
	Evaluation Design	–	–	–	–	√	–	–	–	–	–	–
	Risk analysis	–	–	–	–	√	–	–	–	–	–	–
Development	Game Programming	√	–	√	–	√	–	√	–	–	–	–
	Application prototype	√	–	–	–	√	–	√	–	–	–	–
	Quality assurance	–	–	–	–	√	–	–	–	–	–	–
	Specification document	√	–	–	–	–	–	√	–	–	–	–
	Game integration	–	–	–	–	√	√	–	–	–	√	–
Evaluation	Goal Validation	√	–	√	–	√	–	–	–	√	–	–
	Quality assurance	√	–	–	–	√	–	√	–	–	–	–
	Testing	–	–	–	–	–	–	√	–	–	√	√
	Feedback	–	–	–	√	√	–	–	–	√	–	–
	Maintenance	–	–	–	–	√	–	√	–	–	–	–
	Continuous Improvement Plan	–	–	–	–	–	–	√	–	–	–	–

TABLE V
PEDAGOGICAL AND DIDACTIC ASPECTS CONSIDERED FOR THE DESIGN OF SERIOUS GAMES

Aspects	Utility	Ref.
Participatory strategies	ARGILE allows ensuring the participatory design of rules of the game and involving debate among designers and players.	[20]
Playful pedagogical strategies	It defines objectives to be achieved, pedagogical scenarios, and an adaptation of learning styles according to the children's needs.	[4]
Cognitive Behaviour Theory	It proposes a model for the development of cognitive abilities to change or reinforce with a therapeutic approach the way the student thinks and acts.	[6],[33]
Motivation theory	It evaluates how the game develops student's motivation and commitment to the learning process, improving problem-solving skills, fun, multimodality, and usability.	[19]
Active Learning	Teaching-learning strategy in which the design and implementation are focused on the student.	[22]
Praxis Educational	Experiential learning to increase engagement in gameplay and motivation in players.	[34]
Epistemic Game Theory	It is a type of game that engages the player to immerse himself in simulations of a workspace that emulate the way of thinking and acting to resolve a problem.	[35]
Constructionist Theory	Stimulate learning in children with an active multi-modal engagement mechanism using Piaget´s theories.	[39]
Sociocultural Learning Theory	Describes learning as a social process that plays a fundamental role in the development of cognition.	[47]
Learning Theory	Postulate skill training and knowledge acquisition should be obtained through game mechanics that allow someone to process and retain the knowledge learned.	[27]
Activity Theory	This theory offers a structured model. The basic unit is the activity that interacts with the subject and the object that motivates the interaction with the game.	[17]

In this perspective, Iqbal *et al.* [22] considered it essential to implement pedagogical strategies in the design of SG, because they allow visualizing affective, motivational and behavioral aspects in the students, which influence the acquisition of new knowledge and improvement of the content of the game. Also, it encourages the development of motor, cognitive, psychological and social skills that benefit the learning process [62]. Finally, three studies in [27, 35, 39] presented their findings using constructivist, behaviorist, and cognitivist learning theories applied according to the type of game that is to be developed. These conclusions were structured based on the knowledge to be acquired, and skills to be developed in students [63].

RQ4: What factors affect the design of serious games?

In this process, the authors identified 40 factors that influence the development of SG. These were classified based on the four phases established in research question RQ2.

Factors identified to the analysis phase: The determination of factors related to the requirements, characteristics of the players and pedagogical objectives are necessary for this initial phase. As a result, it found nine elements (approximately 23% of the total), which are shown in Table VI.

The factors most frequently encountered by researchers are the game according to the educational objective and game genre, which has a positive effect and provides an appropriate way to engage students in learning activities and stimulates the cognitive process with inductive-deductive reasoning and problem-solving [64]. Meanwhile, it is vital that the game genre leads the narrative and the mechanics of the activities to be implemented [65]. These can be classified as fast games, linear games, open games, among others. Complementing this study, Rosas *et al.* [66] focused on the incorporation of educational objectives and contents, strengthened by an environment of technological resources available to support learning. These leads are presented as a means of great attraction, and mediator in the cognitive processes of students. On the other hand, the factors less referenced in the revised documents are resources and strengths environment, psychological needs, identity, and learning disorders.

TABLE VI
GENERAL FACTORS IDENTIFIED FOR SERIOUS GAME ANALSYSI PHASE

Factor	References
Game according to educational goals	[25],[46],[48],[29],[17],[3]
Resources and strengths environment	[6]
Psychological needs	[19]
Identity	[35]
Immersion	[35],[45],[46]
Learning Disorders	[33]
Game genre	[33],[30],[27],[3]
Player age	[33], [30]
Geographical location of the player	[33],[15],[28]

Factors identified to the design phase: They are defined as aspects concerning modeling of the application, which contains principal axes like elements of the game, architecture, software components, specification documents and game mechanics. In this phase, 15 factors (38% of the total) could be identified for SG design. Table VII shows these factors. In this classification, game narrative and interactivity factors were the most frequently mentioned in the documents analyzed. In [38, 49] it was defined other essential aspects such as the characterization of the characters, their activities and the role that will play.

Moreover, it is essential to establish feedback processes and rewards, to meet set objectives. Regarding this, Mader *et al.* [30] emphasized that the SG should be designed easily and

intuitively, so that students don't abandon it, being a complicated game. For this reason, SG must have a relationship of participation between players, and enhance navigability, in a is the duration of the activities within the game.

TABLE VII
GENERAL FEATURES ANALYZED FOR SERIOUS GAMES DESIGN PHASE

Factor	References
Reasonable Game Narrative	[25],[38],[31],[45],[49],[27],[17],[3]
Motivating and stimulating learning	[25],[28],[17]
Game rules according to players	[25],[31],[17]
Collaborative environment	[28, 31, 38, 46]
User experience	[15, 26, 30, 31]
Interactivity	[17, 30, 35, 46, 48, 49, 59]
Game complexity	[35, 45, 58]
Duration of activities within the game	[22]
Scenario characteristics	[22, 26]
Communication	[38, 46]
Character characteristics	[15, 45]
Rewards	[15, 29, 42]
Interface aesthetics	[27, 29, 58]
Structure of game levels	[29, 42]
Player-centered actions	[17, 42, 49]

Factors identified to the development phase: this phase refers to the implementation of the educational game, after having completed the design. Here you select tools and high-level programming language, in conjunction with the game engine and 3D modeling software [4]. In this analysis, five factors (13% of total) related to the development of SG were identified, which is shown in Table VIII. The most referenced are integration techniques. It is a transversal management feature of software engineering that integrates input from all domains and the software lifecycle. This component of integration coordinates the generation of the final product.

TABLE VIII
ASPECTS IDENTIFIED IN SERIOUS GAMES DEVELOPMENT PHASE

Factor	References
Technology platform according to game needs	[4]
Flexibility of use of the technological tool	[15]
Game Support Utility	[4]
Application of integration techniques	[16], [15]
Validation of input/output data	[14]

Factors identified to the evaluation phase: this phase is considered an essential element since it includes the evaluation of the educational objective and the objects applied. The review of the results (according to stages of analysis, design, and development) is determined in compliance with the goals implemented in the game, considering the efficiency and experience of the learning process. In this case, 11 factors (27% of the total) were identified, which are presented in Table IX. It is visualized that game feedback factor is the most cited in the documents analyzed. Ushaw *et al.* [42] established this element, friendly and flexible environment, which allows a complete interaction, both for the experienced and novice players [67]. On the other hand, the factor with the lowest degree of reference as a mechanism of control of the resources of the game, that can create a feeling of growth and progress in the player by exploring new experiences. The feedback allows to have a mastery of what has been accomplished and the actions that the player must practice, to have knowledge of the relationships to be developed in the game [68].

Also, Duque [69] referred to the fact that feedback helps the player enrich the level of learning. It becomes an improvement approach to achieve a more granular analysis of the design process based on improvements in the degree of realism, interaction, level of fun, among others. In contrast, the factors that have not been addressed by many researchers are gamer expectations, cognitive development, learning behavior, and gamer satisfaction.

TABLE IX
ISSUES IDENTIFIED FOR SEROUS GAMES EVALUATION PHASE

Factor	References
Gamer Expectations	[6]
Cognitive development	[19]
Learning behavior	[19]
Control of pedagogical quality in the game	[22, 29], [6]
Gamer satisfaction	[33]
Gamer motivation	[26, 28, 33, 48]
Reflexibility	[38]
Game Feedback	[17, 29, 30, 42, 48]
Participation in the game with other family members	[17, 42]
Participatory/Collaborative context	[28, 50]
Attractive and fun game features	[3, 27, 46, 59]

III. Discussion and Conclusions

The results of our research indicate that games with new representations and mechanisms of interaction are an excellent medium for experimentation in the sciences, training, and especially in an educational environment. With this argument, SG works as a mental context, based on specific rules, implemented in electronic devices (computers, tablets, smartphones or game consoles), and that can be used in different areas of knowledge, as a support mechanism to the learning process [70].

As the number of SG users grows significantly and their social and educational impact is high, a review was conducted to analyze the main aspects related to this topic. As a result of this process, 11 approaches and three issues related to the subject of study were identified: phases/stages, pedagogical aspect, and factors.

Active methodologies and frameworks for SG design are widely used for the development of learning competencies, which allow the acquisition of skills and abilities based on the game. It can help in the motor, social, affective aspects and intellectual development of students [45]. This work identified that an essential issue of the implementation of SG is the

formation of a multidisciplinary team made up of software engineers, developers, designers, pedagogues, psychologists, therapists, including the end user. It allows sharing knowledge, needs, and objectives to ensure a significant and successful development of SG [4, 15, 16].
environment where students learn from their mistakes, due to established challenges, which depending on their level of competence and constant feedback, that is capable of strengthening decision-making skills, teamwork, leadership and collaboration [72]. Mariais and Szczesna [26, 31] agreed that for SG design, some factors must be taken into account to achieve effectiveness and efficiency. In [27, 40] it was reported on the importance of other components such as attractive and fun game characteristics, straightforward narrative and genre. These allow the player to meet the established challenges, according to abilities and skill development.

The player's level of knowledge is possible to enhance a visual dynamic that contains interactivity, fun, well-defined rules, risks and immediate feedback, focused on learning objectives, to be achieved through the SG. In [17, 25, 29, 40, 46, 48] it was agreed that game according to educational goals is the central aspect that must be considered in the analysis phase. On the other hand, in [26, 28, 33] it was deemed that a motivation factor plays an important role when designing an SG. However, the element of pedagogical quality in the game is rarely considered by both designers and developers. It can be proven by the fact that, in the documents analyzed, only three studies refer to this important factor.

Aslan and Saavedra [15, 16] consider that characteristics of the game should be identified, to cover the needs in the educational context (analysis phase). It helps, to define a set of criteria that serve as support in the process of game design. It should be interactive and involve all actors (students, teachers, developers, designers, and specialists) [22]. Also, Klapztein & Cipolla [32] describe that for an adequate SG analysis, is necessary to determine the students' skills and the areas of knowledge that must be covered in order to promote engagement.

On the other hand, during the design phase of the games, many objectives could be formulated, but not all should be incorporated into a single game. Designers have to provide a way to identify, synthesize and implement critical goals, which allows for transforming and engaging the interaction sequence [44]. Moreover, it was possible to appreciate that aspects of navigability and flexibility, should be considered when designing SG since it allows the student to make their own decisions based on their academic needs, which should be reviewed in the development of the game and combined with each feedback action that gamers play.

The proper development of an SG serves as a tool that helps the development of player's skills, allows attention to be gained because the game becomes innovative, and the student enjoys the activities. Also, feedback mechanisms must be considered to meet pedagogical and psychological goals that facilitate fun, playability, and consequently improve learning outcomes. Therefore, to choose the type of game to be designed is based fundamentally on the pedagogical objectives posed by the

Consequently, an adequate methodology for SG facilitates the learning process, increases student motivation and commitment, promotes active participation and interaction, and complements aspects of traditional training [71].

In addition, it provides a motivating and engaging multidisciplinary teamwork. At end, in the evaluation phase, it is necessary to test the SG, to guarantee its correct functioning and to be able to detect errors under the highest number of possible situations that can be faced. Furthermore, this phase provides feedback to developers to improve various aspects of the SG.

Finally, this review of the literature helped to identify research gaps, in features related to approaches, phases/stages, pedagogical aspects and factors that influence the design of SG. This work described four phases (analysis, design, development, and evaluation) detailing main characteristics in each of them. The results of this study are essential for the development of good quality SG because there are aspects that have not yet been explored extensively. Moreover, this work could be considered as a baseline for new research projects to develop SG that incorporate game features most effective in promoting engagement and supporting learning.

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