Serious Games when used to Learn Software Processes: An Analysis from a Pedagogical Perspective

Eréndira M. Jiménez-Hernández
Graduate Science and Engineering Computing
National Autonomous University of Mexico,
Mexico City, Mexico
erendira.jimenez@ciencias.unam.mx

Hanna Oktaba
Faculty of Sciences
National Autonomous University of Mexico,
Mexico City, Mexico
hanna.oktaba@ciencias.unam.mx

Mario Piattini
Institute of Technologies and Information Systems
Univesity of Castilla-La Mancha,
Ciudad Real, Spain
Mario.Piattini@uclm.es

Frida Díaz-Barriga
Faculty of Psychology
National Autonomous University of Mexico,
Mexico City, Mexico
fdba@unam.mx

***Abstract*—This paper presents the results of a systematic mapping study conducted to identify the existing serious games used to learn software life cycle processes. Seventy-one studies were selected in the systematic mapping, which were analyzed from a pedagogical perspective. The analysis performed permitted to find areas of contribution that could be employed to create future serious games.**

Keywords—software process, serious game, systematic mapping study, SWOT analysis

I. INTRODUCTION

The ISO/IEC 12207 standard for Software Life Cycle Processes (SLCPs) [1] is a general guide to software product construction, from its conception to its delivery and maintenance [2]; however, the generality of the guide makes it difficult to apply [3-4]. In order to deal with this difficulty, it is necessary to learn a set of Software Engineering best practices. It is at this point that it is possible to observe that there are some serious games, i.e., "games that do not have entertainment, enjoyment or fun as their primary purpose" [5], whose intention is to facilitate the learning of SLCPs practices [6]. It is consequently worth analyzing the pedagogical components of these serious games in order to find an area of opportunity/contribution so as to create more valuable serious games.

We therefore performed an analysis from a pedagogical perspective. In order to accomplish this objective, we carried out two main activities, the first of which consisted of performing a Systematic Mapping Study (SMS) [7] concerning the existing serious games with which to learn SLCPs. The descriptive and statistical information obtained were then used as input to carry out the second activity: an analysis of the Strengths, Weaknesses, Opportunities and Threats (SWOT analysis) [8].

This paper is organized as follows. Section II presents the background and related works. Section III describes the research method that was used to map the serious games employed in the learning of SLCPs. Section IV presents the results obtained from the SMS and also contains the SWOT analysis. Section V discusses the findings and the identified limitations. Our conclusions and further works are summarized in Section VI.

II. BACKGROUND AND RELATED WORKS

"Human culture springs from the game... and with the game develops" [9]. Playing is one of the first actions executed by humans [10] and it is an activity performed in all cultures [11].

The inclusion of games in the learning process is not new. In the 1st century A.C. Quintiliano, in his work "institutionis oratoriae" [12], provided guidelines on how to be a good teacher. He mentioned that education should include games so that "the abhorrence of studies does not occur".

In 1970, Clark Abt considered Quintiliano's approach when creating the first serious game [13]. Since then, serious games have been designed in many areas of knowledge, as mentioned in [14].

Many serious games have been created for Software Engineering in an attempt to facilitate the learning of SLCPs. The problem is that the most of these serious games were not conceived from a pedagogical perspective.

We found a study [6] that presents a serious game named Simsoft, which was created after carrying out a systematic survey of games used for software engineering education. We agree with its authors, who suggest that before the creation of new serious games it is necessary to examine the components of the existing serious games.

The aforementioned work classifies 36 serious games with just one pedagogical aspect: Bloom's Taxonomy [15]. We therefore decided to carry out our own SMS, in order to explore more pedagogical aspects such as the type of target audience, the interaction scheme, the materials/media used by serious games, the goal of the serious games, the means employed to teach, the learning objective and the outcomes of serious games.

In order to attain our objective, we decide to carry out a SWOT analysis of the information obtained from our SMS, since a SWOT analysis makes it possible to study the situation of one project and to propose a future strategy [8]. The SWOT

0-7695-6342-2/17/31.00 ©2017 IEEE
DOI 10.1109/CONISOFT.2017.00031

analysis has been used in many areas such as politics, economics, etc. [16]. However, we were unable to find the usage of a SWOT analysis in combination with an SMS in the area of Software Engineering.

III. RESEARCH METHOD

The research method used to perform the SMS was based on the guidelines provided by Kitchenham and Charters [7], Petersen et al. [17] and Dybå et al. [18]. The SMS was conducted in three stages: planning, conducting and reporting. The first and second stages are described in the following sub-sections (*A* and *B*), while the reporting stage is presented in sub-section *A* of the Section IV.

A. Planning stage

In this stage, the following activities in order to create a review protocol were performed: (1) establishment of the research question, (2) definition of the data sources and the search strategy, (3) establishment of the selection criteria, (4) definition of the data extraction strategy, (5) quality assessment and (6) selection of synthesis methods. Each of these is explained in detail as follows.

1) Research question

In order to examine the current use of serious games in the learning of SLCPs practices, it was first necessary to establish the main research question. This was:

Have any serious games been designed for the purpose of learning software life cycle processes?

The main research question was then divided into detailed sub-questions with the objective of categorizing and summarizing the knowledge concerning the use of serious games to learn SLCPs. Table I shows these research sub-questions along with their motivation.

TABLE I. RESEARCH SUB-QUESTIONS

Research sub-questions	Motivation
Q1. Which SLCPs can be learned using the serious game?	To discover which SLCPs are most frequently learned by means of serious games.
Q2. What type of serious game is it?	To discover which types of serious games are most frequently employed to learn SLCPs.
Q3. What is the audience of the serious game?	To determine the population sectors that makes use of serious games to learn SLCPs.
Q4. What is the interaction scheme of the serious game?	To discover which interaction dynamics are most frequently used in serious games.
Q5. Which media or materials are used in the serious game?	To discover which types of media or materials are most frequently used in serious games, and which types can be applied in conjunction with others.
Q6. What is the goal of the serious game?	To discover what the most frequent gaming purposes are.
Q7. What is the teaching approach of the serious game?	To discover which means of teaching serious games are most frequently employed, and which of them can be applied in conjunction with others.
Q8. What is the learning objective of the serious game?	To discover what the most frequent levels of learning achieved by players are.
Q9. What is the outcome of the serious game?	To discover what the most frequently benefits obtained by players are.

2) Data sources and search strategy

The search strategy included electronic databases. The following databases were used (see Table II):

TABLE II. SELECTED DATABASES

Database	Location
Springer (SP)	www.springer.com
Science Direct (SD)	www.sciencedirect.com
Wiley Online Library (WILEY)	onlinelibrary.wiley.com
IEEEXplorer (IEEE)	ieeexplore.ieee.org
Scopus (SC)	www.scopus.com
ACM Digital Library (ACM)	dl.acm.org

In order to perform the search in the selected digital libraries, a search string consisting of three parts were used (see Table III). The first part is related to studies that include games, the second part has words related to education, and the third part refers to terms related to SLCPs. The synonym terms were joined using the Boolean operator "OR", while the "AND" operator was used to join parts.

The period reviewed included studies published between 2000 and December 2016, in English.

TABLE III. SEARCH STRING APPLIED

Concept	Alternative terms and synonyms	
Game	(game OR play OR ludic OR serious game OR simulation)	AND
Education	(education OR learning OR teaching OR training OR edutainment)	AND
SLCPs	((software OR system) AND ((process) OR (engineering OR development OR project OR management OR design OR quality OR requirements)))	

The search was conducted by applying the search string to the same metadata (i.e., title, abstract and keywords) in all the sources.

3) Establishment of selection criteria

The inclusion criteria (IC) of the SMS are shown in Table IV; the exclusion criteria (EC) are shown in Table V.

TABLE IV. INCLUSION CRITERIA

IC	Description
1	Papers that fulfill the search string.
2	Journals, conferences and workshop papers.
3	Papers written in English.
4	Papers published between 2000 and December 2016.

TABLE V. EXCLUSION CRITERIA

EC	Description
1	Duplicate papers (same research in different databases).
2	Papers available only in the form of slides, posters, books and technical reports.

In those cases in which it was found several articles describing the same work, the most recent was included.

4) Data extraction strategy

The extraction form was designed by considering a set of possible answers for each sub-question that had been defined. The possible answers are explained in more detail as follows.

With regard to Q1 (Learned software life cycle processes), a paper could be classified in one of the ISO/IEC 12207 processes:

(a) System life cycle processes: if the serious game makes it possible to learn all the processes included in classifications between a.1 and a.4.
  (a.1) Agreement processes.
  (a.2) Project processes.
  (a.3) Technical processes.
  (a.4) Organizational Project-Enabling processes.
(b) Software Specific Processes: if the serious game makes it possible to learn all the processes included in classifications between b.1 and b.3.
  (b.1) Software Implementation Processes.
  (b.2) Software Support Processes.
  (b.3) Software Reuse Processes.

With regard to Q2 (Type of serious game), a paper could be classified in one of the following categories:

(a) Edutainment: if the serious game is the combination of education and entertainment [19].
(b) Educational game: if the serious game is designed to enhance learning. An educational game is generally designed to enhance the capabilities of employees, because the players apply all the things learned through the serious game in the real world [20].
(c) Simulator: if the serious game involves participants in 'as-if' or 'simulated' actions and circumstances with the aim of learning something, allowing the participants to assume values and attitudes that they would not normally have [21].
(d) Persuasive game: if the serious game uses the persuasion technology. The game influences players to take actions [22].
(e) Organizational-dynamic game: if the serious game teaches and reflects on the dynamics of organizations at three levels: individual, group and cultural [23].

With regard to Q3 (Audience of the serious game), a paper could be classified in one of the following categories:

(a) Novice professionals.
(b) Expert professionals.
(c) Students.

With regard to Q4 (Interaction scheme of the serious game [24]), a paper could be classified in one of the following categories:

(a) Collaborative scheme.
(b) Competitive scheme.
(c) Individualistic scheme.

With regard to Q5 (Media/materials used by the serious game), a paper could be classified in one of the following categories:

(a) Computer (virtual): if the serious game requires the use of a computer.
(b) Material: if the serious game requires the use of physical objects.
(c) Performance: if the serious game involves acting a role.
(d) Combined (virtual and material).
(e) Combined (virtual and performance).
(f) Combined (performance and material).

With regard to Q6 (Goal of the serious game), a paper could be classified in one of the following categories:

(a) Educate.
(b) Change behavior.

With regard to Q7 (Way of teaching of the serious game), the VARK model [25] was employed for the following classification. A paper could be classified in one of the following categories:

(a) Visual.
(b) Auditory.
(c) Reading/Writing.
(d) Kinesthetic.
(e) Combined (Reading/Writing and Kinesthetic).
(f) Combined (Reading/Writing and Visual).
(g) Combined (Visual and Kinesthetic).

With regard to Q8 (Learning objective of the serious game), the model of learning objectives [26-27] was employed for the following classification. A paper could be classified in one of the following categories:

(a) Remember.
(b) Understand.
(c) Apply.
(d) Analyze.
(e) Evaluate.
(f) Create.

With regard to Q9 (Serious game outcome), the KSA model [28] was employed for the following classification. A paper could be classified in one of the following categories:

(a) Knowledge.
(b) Skills.
(c) Abilities.
(d) Other characteristics: if, after the usage of the serious game, a person modifies/acquires new interests, training, or experiences.
(e) Combined (Knowledge and abilities).

5) Quality assessment

A three-point Likert-scale questionnaire [29] was designed to provide a quality assessment of the primary studies. The questionnaire contained four subjective closed-questions and one objective closed-question, see Appendix A [30]. The subjective questions are those that correspond to items a, b, c and e. The objective question is item d.

The first three questions on the quality assessment form make it possible to evaluate the research design of the serious games for the learning of SLCPs. The fourth question permits us to evaluate the rigor and credibility of the studies. The last one allows the relevance of the study results to be evaluated.

Each selected study has a score of between 1 and 3 for each question. Number 1 represents "disagree", number 2 represents "somewhat agree" and number 3 represents "agree".

The average of the five closed-question scores obtained for each study provides a final score (a real number between 1 and 3). The final score makes it possible to calculate a percentage of quality per study (1 corresponds to 0%, and 3 corresponds to 100%).

These scores were used to exclude studies from the SMS: if their percentage of quality were less than 80%.

6) Synthesis methods

The method used to synthesize the results is based on counting the primary studies that are classified in each answer for our research sub-questions and counting the number of papers found in each bibliographic source per year. Then the benefits and limitations of the serious games used to learn the SLCPs were summarized.

Namely, quantitative and qualitative synthesis methods were used.

B. Planning stage

Fig.1 shows the number of papers identified after the application of the review protocol mentioned in sub-section *A*.

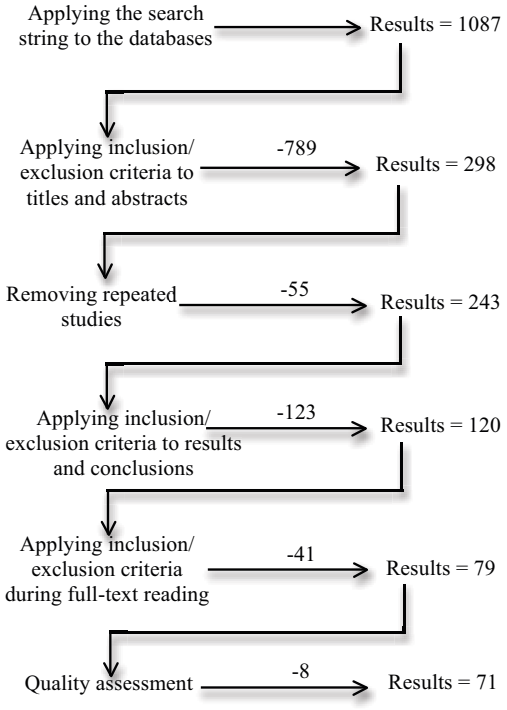

Figure. 1. Number of papers included during the study selection processes

The searches carried out in the six electronic databases led to the discovery of 1087 studies.

The titles and abstracts of each study were evaluated in order to decide whether or not the studies should be included. Those studies that fulfilled the selection criteria were included. At this point, 298 articles from the 1087 initial studies were selected. The source of each citation were stored and 55 repeated studies were removed.

The selection criteria were then applied to the results and conclusions sections, after which 120 studies were selected.

The full-text of the 120 studies was read, and the inclusion and exclusion criteria were applied. This led to the selection of 79 studies. In this phase, the quality assessment was carried out, and the information from each paper was extracted using the form shown in Appendix B [30]. Therefore 71 articles were selected as primary studies.

IV. RESULTS

A. Systematic Mapping Study Results

As result of the conducting stage of the SMS (see Section 3.2), it was decided to select 71 studies. The complete list of the primary studies selected is presented in Appendix C [30].

The primary studies were categorized according to the possible answers of the 9 research sub-questions, see Appendix D [30]. Then, the number of studies that corresponded with each answer was counted so as to calculate the overall results (see Table VI).

TABLE VI. RESULTS OF THE SYSTEMATIC MAPPING

Research sub-questions	**Possible answers**	**Results**	
		Number of studies	Percentage
Q1. Which SLCPs can be learned using the serious game?	**a. System Life Cycle Processes**	**30**	**42.2%**
	a.1 Agreement Processes	1	1.4%
	a.2 Project Processes	2	2.8%
	a.3 Technical Processes	11	15.5%
	a.4 Organizational Project-Enabling Processes	16	22.5%
	b. Software Specific Processes	**41**	**57.8%**
	b.1 Software Implementation Processes	27	38%
	b.2 Software Support Processes	13	18.4%
	b.3 Software Reuse Processes	1	1.4%
Q2. What type of serious game is it?	a. Edutainment	25	35.2%
	b. Educational game	7	9.9%
	c. Simulator	18	25.4%
	d. Persuasive game	9	12.7%
	e. Organizational-dynamic game	12	16.9%
Q3. What is the audience of the serious game?	a. Novice Professionals	7	9.9%
	b. Expert Professionals	4	5.6%
	c. Students	60	84.5%
Q4. What is the	a. Collaborative	21	29.6%

interaction scheme of the serious game?	b. Competitive c. Individualistic	12 38	16.9% 53.5%
Q5. Which media or materials are used in the serious game?	a. Computer (virtual) b. Material c. Performance d. Combined (virtual and material) e. Combined (virtual and performance) f. Combined (performance and material)	49 8 7 2 3 2	69% 11.3% 9.9% 2.8% 4.2% 2.8%
Q6. What is the goal of the serious game?	a. Educate b. Change behavior	55 16	77.5% 22.5%
Q7. What is the teaching approach of the serious game?	a. Visual b. Auditory c. Reading/Writing d. Kinesthetic e. Combined (Reading/Writing and Kinesthetic) f. Combined (Reading/Writing and Visual) g. Combined (Visual and Kinesthetic)	10 0 8 16 15 17 5	14.1% 0% 11.3% 22.5% 21.1% 23.9% 7%
Q8. What is the learning objective of the serious game?	a. Remember b. Understand c. Apply d. Analyze e. Evaluate f. Create	10 26 12 17 6 0	14.1% 36.6% 16.9% 23.9% 8.5% 0%
Q9. What is the outcome of the serious game?	a. Knowledge b. Skills c. Abilities d. Other characteristics (personality, preferences, interest) e. Combined (Knowledge and abilities)	27 0 11 2 31	39.1% 0% 15.9% 2.9% 44.9%

Note: the summation of the percentages is therefore over 100%

Fig. 2 shows the classifications of the primary studies according to the possible answers for Q1. The graph indicates the trend regarding the teaching aim of the serious games; the strongest aim is related to topics concerning software implementation processes (27 primary studies). The main reason for this result is that most of the studies show how to learn basic elements of programming (e.g. arrays, data types, operators, loops, etc.), programming paradigms (e.g. Object Oriented Programming), data structures (e.g. trees, queues and stacks) and programming languages (e.g. C#, C++, .Net and HTML5); all of these are part of the software construction process, which belongs to the software implementation processes.

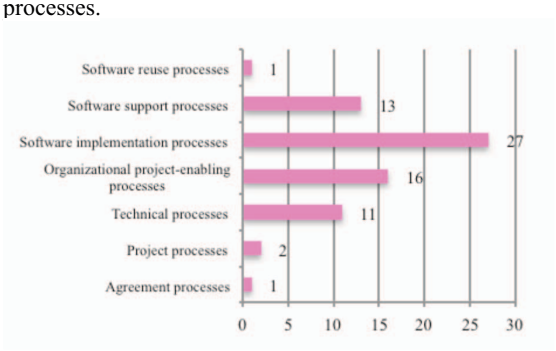

Figure. 2. SLCPs taught using serious games

Fig. 3 shows the answers obtained for Q2. The most common type of serious game used to teach SLCPs is Edutainment (25 primary studies), while the type least used is the Educational Game (7 primary studies).

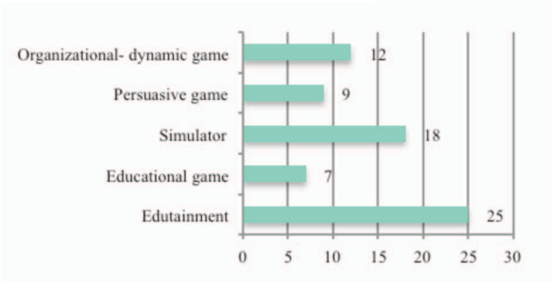

Figure. 3. Types of serious games for the learning of SLCPs

Upon analyzing of the answers for Q2 (see Fig.3) and Q3 (see Fig.4), it was noticed that there is a correlation between the type of serious game and its audience. In most cases, the educational and persuasive serious games are directed at practitioners, and the other types of serious games are directed at students.

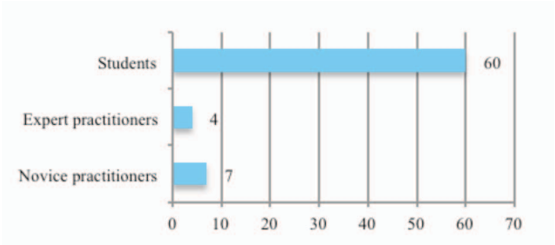

Figure. 4. Audience of serious games for the learning of SLCPs

Fig. 5 shows the numbers of the three types of interaction schemes of serious games (Q4). The graph shows that the most common type is individualistic (38 primary studies) and the least used type is competitive (12 primary studies).

The individualistic dynamic is that most employed, because it makes it possible to rate a student's score, bearing in mind that most serious games are directed at students.

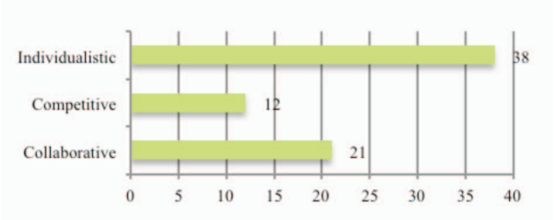

Figure. 5. Types of interaction schemes of serious games for the learning of SLCPs

In Fig. 6, it is possible to observe that 49 of the serious games for the learning of SLCPs make use of computers. The least used media are the combination of performance and material (2 primary studies) and the combination of virtual and material (2 primary studies); this corresponds with the answers obtained for Q5.

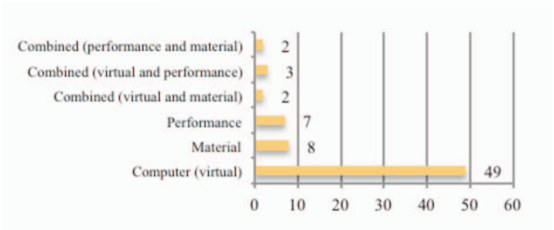

Figure. 6. Types of media/materials used by the serious games for the learning of SLCPs

With regard to the answers for Q6, it was found that in 55 of the serious games (see Fig.7) the goal is to educate. This is related to the results for Q3, because the 84.5% of the serious games were designed for students (see Table 6).

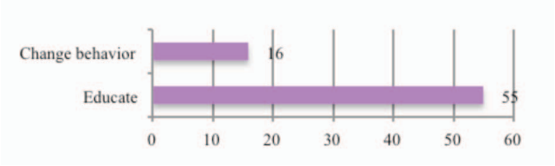

Figure. 7. Goals of the serious games for the learning of SLCPs

Fig. 8 shows that the most common means employed to teach is the combination of reading/writing and visual (17 primary studies), followed by kinesthetic learning style (16 primary studies). It was not found any serious games that teach aurally; this corresponds to the answers for Q7.

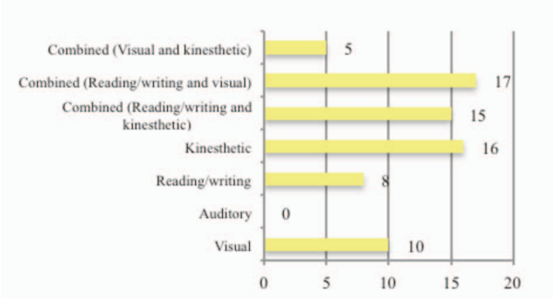

Figure. 8. Teaching approach of the serious games for the learning of SLCPs

With regard to the answers for sub-question Q8 (see Fig.9), it was found that it is difficult to obtain the highest level of learning (Create, 0 primary studies). This number is related to the results of the audience of the serious games (Q3), because in order to obtain the highest levels of learning, it is necessary to have the lowest levels. This is not easy for students to attain owing to their low professional experience; this most commonly occurs with practitioners, who are those least covered in the existing serious games.

Since the most frequent goal of the serious games (see Table VI) is to educate (77.5%), and the majority of them are directed at students (84.5%), it is most frequent that the serious games of the primary studies solely permit players to reach the learning levels of remember (14.1%), understand (36.6%), apply (16.9%) or analyze (23.9%).

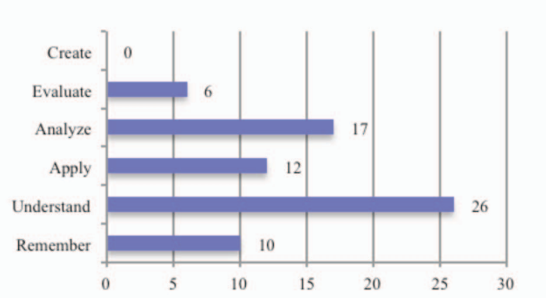

Figure. 9. Learning objectives of the serious games for the learning of SLCPs

The answers for Q9 (see Fig. 10) show that the most frequent serious game outcome is a combination of knowledge and abilities (31 primary studies).

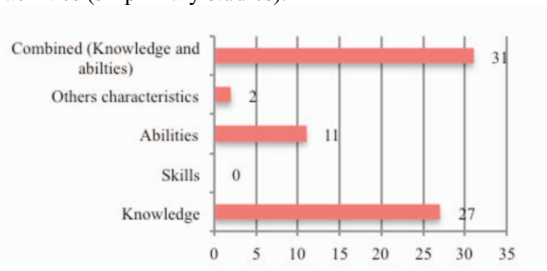

Figure. 10. Outcomes of the serious games for the learning of SLCPs

Fig. 11 shows that the two journals with most papers related to serious games for the learning of SLCPs (4 primary studies) are Computers & Education and Education Transaction Technologies.

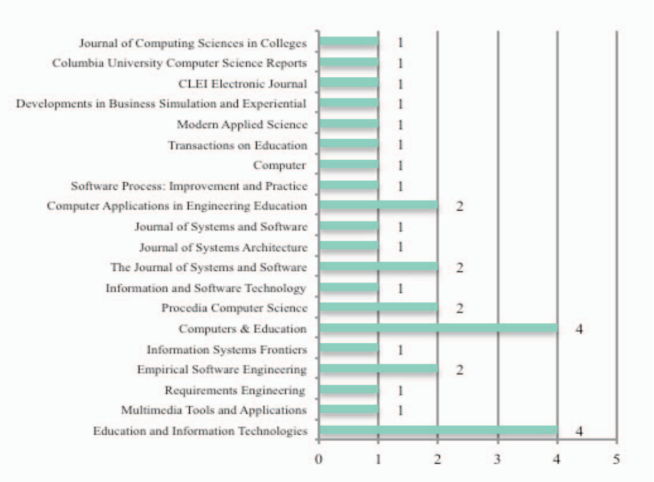

Figure. 11. Journals in which the primary studies were published

Fig. 12 shows that the two conferences with most papers related to serious games for the learning of SLCPs (6 primary studies) are FIE (Frontiers in Education Conference) and CSEE&T (Conference on Software Engineering Education and Training). The majority of the selected primary studies were published at conferences (36 papers). Thirty papers in journals and five papers in workshops were found.

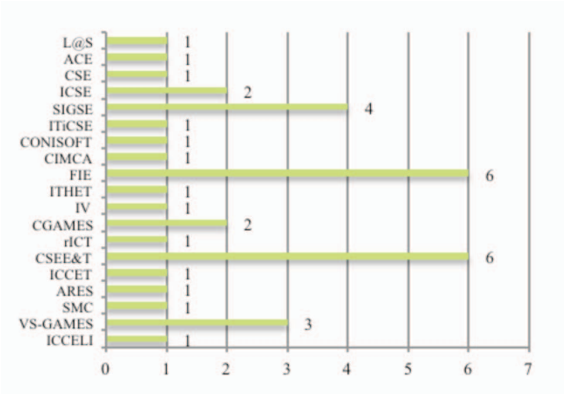

Figure. 12. Conferences at which the primary studies were published

The International Workshop on Games and Software Engineering has the majority of the selected primary studies (2 papers), as it can be observed in Fig. 13.

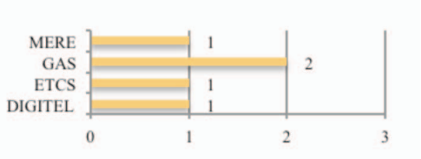

Figure. 13. Workshops at which the primary studies appeared

Fig. 14 shows the number of selected publications on serious games for the learning of SLCPs by year and source. The analysis of the number of research studies showed that there has been a growth in interest in this topic, particularly since 2005.

The electronic database with most studies related to serious games for the learning of SLCPs is IEEE (29 primary studies), and the source with the least publications related to them is WILEY (3 primary studies).

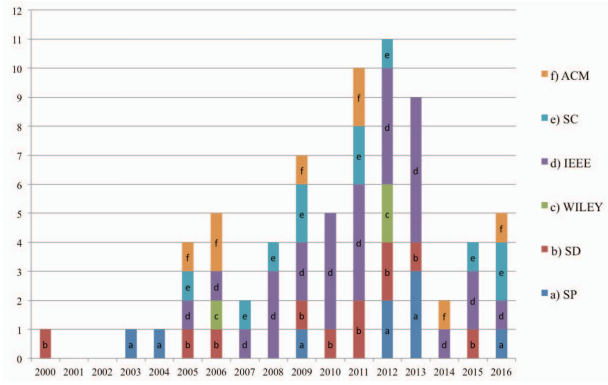

Figure. 14. Number of primary studies by year and source

B. SWOT Analysis Results

After considering the results of sub-section *A* of Section IV, an analysis of the strengths, weaknesses, opportunities and threats was carried out.

Table VII shows the strengths for primary studies in the case of each research sub-question.

TABLE VII. STRENGTHS FOR PRIMARY STUDIES IN CASE OF RESEARCH SUB-QUESTIONS

ID	Strength
Q1	There are studies of serious games with which to learn all SLCPs.
Q2	There are studies of all types of serious games (edutainment, educational, simulator, persuasive and organizational-dynamic) with which to learn SLCPs.
Q3	Most of the studies guide their efforts toward teaching SLCPs to students.
Q4	The majority of the studies of serious games (38%) have an individualistic dynamic, which makes it possible to evaluate each person's learning more accurately.
Q5	The majority of the studies of the serious games are distinguished by the usage of the computer as a media to teach (69%); the audience of the games is familiarized with computers.
Q6	In 77.5% of the studies of serious games, the main purpose is to educate.
Q7	In the existing studies of serious games with which to learn SLCPs, almost all teaching methods (visual, reading/writing and kinesthetic) are used.
Q8	In 67.6% of the studies of serious games with which to learn SLCPs, it is possible to learn from the level of "remember" to a level of "analyze".
Q9	The majority of the studies of serious games allow the players to acquire knowledge and abilities related to SLCPs (44.9%).

Table VIII shows the weaknesses for primary studies in the case of research sub-question Q1-Q9

TABLE VIII. WEAKNESSES FOR PRIMARY STUDIES IN CASE OF RESEARCH SUB-QUESTIONS

ID	Weakness
Q1	There is only one primary study of a serious game that can be used to learn agreement processes and one for software reuse processes. It was not found a constructed serious game that makes it possible to learn ISO/IEC 12207, only an approach in [31]
Q2	Only a 9.9% of the studies deal with educational serious games and 12.7% contain persuasive serious games whose purpose is to learn SLCPs.
Q3	Only a 15.5% of the studies of serious games for the learning of SLCPs that are directed at software practitioners (novices and experts).
Q4	In practice, software is constructed in a team. Only 29.6% of the studies of serious games permit the learning of the SLCPs in a collaborative environment.
Q5	There are few studies of serious games that use more than one media or material to teach SLCPs (2.8% combine virtual and material, 4.2% combine virtual and performance, 2.8% combine performance and physic materials).
Q6	There are few studies of serious games with which to change behavior (22.5%).
Q7	There are no studies of serious games with which to learn SLCPs aurally.
Q8	Only the minority of studies of serious games makes it possible to achieve the learning objectives of evaluation (8.5%) and there are none for create (0%)
Q9	There are no studies of serious games that allow the learning of SLCP skills, and only a few studies allow to the players to acquire other characteristics such as a personality, interest, among others (2.9%).

Table IX shows the opportunities for primary studies in the case of each research sub-question Q1-Q9

TABLE IX. OPPORTUNITIES FOR PRIMARY STUDIES IN CASE OF RESEARCH SUB-QUESTIONS

ID	Opportunity
Q1	To design serious games that will make it possible to learn agreement processes, software reuse processes and project processes, or to include all processes, because they are those less frequently exploited.
Q2	To create persuasive or educational serious games, because they are best suited to the training of software practitioners, and those types of serious games are less exploited.
Q3	To design serious games for professionals; specifically, for expert professionals, because there are only a few serious games for them.
Q4	To design serious games with which to learn SLCPs with a collaborative interaction scheme, because it is most compatible with the way in which software is made in the real world.
Q5	To design serious games that combines the usage of computers, physical materials and performance. This would permit the players to have different options as regards learning SLCPs.
Q6	To design serious games with which to change behavior, because this is one of the biggest problems during the adoption of new practices, and they are the least exploited.
Q7	To employ all means of teaching (visual, auditory, reading/writing and kinesthetic) to construct serious games so as to increase the learning of SLCPs.
Q8	To design games with which to attain the highest levels of learning (evaluate and create).
Q9	To create serious games with which to acquire knowledge and/or abilities and/or other characteristics.

Table X shows the threats to the primary studies in the case of each research sub-question Q1-Q9

TABLE X. THREATS FOR PRIMARY STUDIES IN CASE OF RESEARCH SUB-QUESTIONS

ID	Threat
Q1	Agile methods are more frequently used every day. This is leading software entities to move away from the usage of traditional software development processes [32] such as ISO/IEC 12207.
Q2	Strengthening knowledge or persuading people are not easy, because they involve changing the way of doing some of their tasks at work [33].
Q3	It is difficult to convince the directors/owners of the software entities to train their employees, particularly if it means learning through play [34].
Q4	It is more difficult to evaluate the learning of a group of people [24].
Q5	If virtual serious games are developed, it will be difficult to "compete" with the graphics of the video games industry [34].
Q6	It is not easy to change behavior because it involves changing personality, interests, etc. [28].
Q7	It is not easy to design a serious game for the learning of SLCPs that contains several means of teaching [25].
Q8	The taxonomy of Anderson [26] is hierarchical. It asserts that in order to achieve the highest levels of learning, it is necessary to acquire previous levels. To construct serious games to educate people in SLCPs up to the highest levels of learning, it is necessary to assess the players' previous knowledge (diagnostic test) and give options so as to facilitate the acquisition of knowledge that they do not possess; this is not simple.
Q9	Players can acquire knowledge and/or skills and/or other characteristics; but it is necessary for them to acquire generic competences and not only specific competences, which is not a trivial task [35].

A SWOT analysis enabled us to identify the following areas of opportunity or contribution:

Constructing serious games of the persuasive and educational types for the teaching of SLCPs.

Facilitating the learning of software reuse processes, agreement processes, or project processes through serious games.

Directing serious games for the learning of SLCPs at software expert practitioners.

Facilitating the learning of software processes with collaborative serious games.

Creating serious games with which to attain the highest levels of learning (evaluate and create) of SLCPs.

Construct serious games for the learning of SLCPs that make use of media/materials: computers (virtually), physic materials and performance.

Developing serious games that employ the four means of teaching (visual, auditory, reading/writing and kinesthetic) for the learning of SLCPs.

V. DISCUSSION

Would it be possible to remember the most pleasant, self-motivated and recreational behaviors without associating them with the games in our lives? The answer to this question motivated us to perform the work described in this paper. We therefore carried out a pedagogical analysis which has allowed us to propose that serious games are an excellent educational device, i.e., "a complex artifice, thought-out and/or used to suggest alternatives of action" [36] by which to learn SLCPs. This is owing to the fact that the ludic experience of serious games is not only highly enjoyable, but also makes it possible to acquire knowledge and increase abilities. Serious games are based on problem-based learning [37], decision science [38] and experiential education [39].

Currently, with the increase in gambling behavior in virtual spheres, and the emergence of a variety of modes of unexpected games, it is necessary to rethink the theory and research on games, discarding the idea that only children play and that the player's satisfaction and engagement only serves to "waste time".

In the case of serious games, we should emphasize their experiential or manipulative character, as regards both ideas and objects. It would appear that therein lies one of the most successful aspects in the field of education and entertainment: "manipulation involves practicing a task and exercising a routine, which increases the degree of experience. Over time, experience increases the expertise of the person. Therefore, manipulation is associated with the following characteristics: practice, execution and experience" [40]

In order to promote the creation of more serious games so as to facilitate the learning of SLCPs, it would be advisable to make an effort to attempt to establish a standard definition of serious games. This work has permitted us to identify that there is a problem in the usage of the definition of serious game. This may be owing to the great diversity of definitions of serious games, as Djaouti mentions in [41].

Besides the searches included in this article, we have also made informal searches (e.g. using Google), in which we found serious games created in some software entities. It is therefore necessary for researchers to work in closer proximity with those software entities in order to spread their contributions to the scientific community, as occurs in [42].

We consider that it is also important to explain the classification used in research sub-question Q8. We know it has been more than fifty years since the American Psychological Association, under the coordination of Benjamin Bloom created the Taxonomy [15], which bears the name of the researcher, in order to generate a theoretical framework and a common model of assessment of thought abilities. This taxonomy is in force, except in some settings established earlier this century.

We have therefore recovered the aforementioned model in accordance with the rethink of Anderson & Krathwohl [26] in order to distinguish the progression between low and high level thinking abilities: remember, understand, apply, analyze, evaluate, create (or synthesize).

We have also considered the approach of Churches [27], who established the first two levels as a stage of knowledge acquisition, the next two as acquiring a greater depth of knowledge, and the last two (evaluate and create or synthesize) as the creation of knowledge.

The field of learning based on serious games is open to research and innovation as regards the methods themselves so as to attain an appropriate techno-pedagogical design, and to assess their impact on the learning, emotions, creativity and social practices of the target users. This is another great challenge, because educational research tends to focus on measuring the acquisition of factual and conceptual curriculum.

VI. CONCLUSIONS AND FURTHER WORK

In this paper, we have presented a new means to identify an area of opportunity/contribution in research: gathering information through an SMS and interpreting its results with a SWOT analysis.

This paper led us to the realization that there is great interest in serious game development for the learning of SLCPs.

Nevertheless, it is necessary for researchers in the areas of Software Engineering, Pedagogy and Psychology to work together in order to create better ludic strategies.

In the future, we intend to construct serious games based on the areas of opportunity/contribution identified. If we construct serious games based on this, we shall:

- Personalize education with the serious games constructed. Personalized learning is "the adjustment of educational activities to the personal characteristics of each apprentice" [43]. We shall achieve this through the inclusion of the four means of teaching and the three types of media/materials described in the contribution area.
- Use scenarios in the serious games, which will encourage decision-making; the players will acquire complex thought, which "is a thought that relates and complements" [44]. Complex thought enables the highest levels of learning to be attained.
- Include a media/material with which to facilitate communication between players (e.g. chat), and our serious games would also be "friendly" with the new learning ecology. The new learning ecology is an environment of shared knowledge, in which individuals share knowledge, experiences, values, etc. using technology [45].

Other approaches that we shall consider in order to create our serious games will be the 6 phases proposed by [46] for the construction of serious games, the 5 phases proposed by [47] and the seven complex lessons in education for the future [48], while for the construction of virtual serious games, we shall consider the 36 learning principles of [49].

ACKNOWLEDMENT

This work has been funded by the CONACyT grant scholarship program and as part of the GINSENG Project, (TIN2015-70259-C2-1-R) (MINECO/FEDER) funded by the

Fondo Europeo de Desarrollo Regional and Ministerio de Economía y Competitividad.

REFERENCES

[1] IEEE, "International Standard ISO/IEC 12207- Systems and software engineering-Software life cycle processes", IEEE, 2008.

[2] F.F. Tsui, Essentials of software engineering, 4th ed., Jones & Bartlett Publishers, 2016.

[3] H. Oktaba and M. Piattini (Eds), "Software Process Improvement for Small and Medium Enterprises", in Techniques and Case Studies, Information Science Reference, 2008, pp. 42-70.

[4] F. Marcondes, "Problem on Software Engineering Learning: Domain Engineering", International Conference on Information Technology: New Generations USA, pp. 1636, April 2009.

[5] D. Michael and S. Chen, Serious games: games that educate, train, and inform, Course Technology PTR, 2005.

[6] C. Caulfield, J. Xia, D. Veal, and P. Maj, "A systematic survey of games used for software engineering education", Modern Science, vol.5, no.6, pp. 28-43, 2011.

[7] B. Kitchenham and S. Charters, "Guidelines for performing Systematic Literature Reviews in Software Engineering", Technical Report EBSE-2007-01, UK: Software Engineering Group of Keele University Durham, 2007.

[8] G. Smith and C. Christensen, Policy Formulation and Administration, Richard D. Irwin, 1951, pp. 14.

[9] J. Huizinga, Homo Ludens. A study of the play-element in culture, London: Routledge & Kegan Paul, 1949.

[10] S. Freud, "Jenseits des Lustprinzips", Internationaler Psychoanalytischer Verlag, vol.3, pp. 251, 1943.

[11] R. Caillois, Les jeux et les hommes, France: Gallimard, 1958, pp.42-43.

[12] A. Ortega-Carmona, "About the formation of orator", Universidad Pontificia de Salamanca, vol. 3, pp. 8-10, 1996.

[13] C. Abt, Serious games, UPA, 2002, pp. 1-17.

[14] D. Djaouti, J. Alvarez, J. Jessel, and O. Rampnoux, "Origins of serious games", Serious games and edutainment applications, pp.25-43, 2011.

[15] B. Bloom, Taxonomía de los objetivos de la educación, Ateneo, 1981, pp.162-167.

[16] L. Fine, The SWOT Analysis: Using your Strength to overcome Weaknesses, Using Opportunities to overcome Threats, CreateSpace Independent Publishing Platform, 2009, pp. 23-49.

[17] K. Petersen, S. Vakkalanka, and L. Kuzniarz, "Guidelines for conducting systematic mapping studies in software engineering: an update", Information and Software Technology, vol. 64, pp. 1-18, 2015.

[18] T. Dybå and T. Dingsøyr, "Empirical studies of agile software development: A systematic review", Information and Software Technology, vol.50, pp. 833-859, 2008.

[19] F. Paraskeva, S. Mysirlaki, and A. Papgianni, "Multiplayer online games as educational tools: Facing new challenges in learning", Computers and Education, vol. 54, pp. 498-505, 2010.

[20] M. Prensky, Digital Game-Based Learning, Paragon House, 2007, pp. 249-258

[21] A. Warr and O. Eamonn, "Understanding Design as a Social Creative Process", Conference on Creativity & Cognition United Kingdom, pp. 118-127, April 2015.

[22] V. Visch, N. Vegt, H. Anderiesen, and K. Van der Kooij, "Persuasive Game Design: A model and its definitions", Conference on Changing Perspectives, pp. 107-110, 2013.

[23] M. Curz-Cunha, Handbook of Research on Serious Games as Educational, Business and Research Tools, IGI Global, 2012, pp. 539-558.

[24] E. Wenger, Cultivating Communities of Practice (Hardcover), Harvard Business Press, 2002, pp. 1-45.

[25] F. Hawk and A. Shah, "Using Learning Style Instruments to Enhance Student Learning", Decision Sciences Journal of Innovative Education, vol.5, pp. 1-19, 2007.

[26] L. Anderson and D. Krathwohl, A taxonomy for learning, teaching and assessing: a revision of Bloom's Taxonomy of educational objectives, Longman, 2001, pp. 1-82.

[27] A. Churches, "Educational origami, Bloom's and ICT tools", 2007. [Online]. Available: http://edorigami.wikispaces.com/Bloom's+and+ICT+tools

[28] N. Peterson, M. Mumford, W. Borman, P. Jeanneret, and E. Fleishman, An occupational information system for the 21st Century, American Psychological Association, 1999, pp. 67-89.

[29] R. Likert, "A Technique for the Measurement of Attitudes", Archives of Psychology, vol. 140, pp. 1-55, 1932.

[30] E. M. Jiménez-Hernández, H. Oktaba, M. Piattini, and F. Díaz-Barriga, "Appendices of the analysis from a pedagogical perspective of the serious games for learning SLCPs", 2017. [Online]. Available: www.erendirajimenez.mx

[31] U. Aydan, M. Yilmaz, and R. O'Connor, "Towards a Serious Game to Teach ISO/IEC 12207 Software Lifecycle Process: An Interactive Learning Approach", Communications in Computer and Information Science, pp. 217-229, 2015.

[32] P. Abrahamsson, J. Warsta, M. Siponen, and J. Ronkainen, "New directions on agile methods: a comparative analysis", International Conference on Software Engineering USA, pp. 244-254, 2003.

[33] I. Bogost, Persuasive games: The expressive power of videogames, The MIT Press, 2007, pp. 1-20.

[34] T. Susi, M. Johannesson, and P. Blacklund, "Serious games– An overview", Technical Report HS-IKI-TR-07-001, 2007, pp. 7.

[35] J. González and R. Wagenaar (Eds), Tuning Educational Structures in Europe, Universidad de Deusto, 2003, pp. 71-76

[36] L. Sanjurjo, Devices for training in professional practices, Argentina: Homo Sapiens, 2009, pp.6

[37] M.S. Baden and C.H. Major, Foundations of problem-based learning, McGraw-Hill International, 2004.

[38] J.R. Raser, Simulation and society: an exploration of scientific gaming, Boston: Allyn and Bacon, 1969.

[39] D.A. Kolb, Experiential learning: experience as the source of learning and development, Prentice-Hall Englewood Cliffs, 1984.

[40] A. Matas-Terrón, "Serious games and adult education", 2015. [Online]. Available: http://riuma.uma.es/xmlui/bitstream/handle/10630/9618/JS_ALV.pdf?sequence=1

[41] D. Djaouti, J. Alvarez, J. Jessel, and O. Rampnoux, Origins of Serious Games, Serious Games and Edutainment Applications, Springer, 2011, pp.25-43.

[42] M. Morales-Trujillo, H. Oktaba, and J. González, "Improving software projects inception phase using games ActiveAction workshop", Conference on Evaluation of Novel Approaches to Software Engineering Portugal, pp.1-8, 2014.

[43] J. Rué, L'organització social de l'ensenyament-aprenentatge i l'agrupament dels alumnes, Spain: Universitat Autònoma de Barcelona, 1991, pp. 21-31

[44] E. Morin, On complexity, Hampton Press, 2007, pp. 1-94.

[45] H. Spires, E. Wiebe, C.A. Young, K. Hollebrands, and J. Lee, "Toward a new learning ecology: teaching and learning in 1:1 environments", Friday Institute White Paper Series, pp. 1-26, 2009.

[46] M. Bertrand, B. Huynh-Kim-Bang, and M. Labat, "Articuler motivation et apprentissage grâce aux facettes du jeu sérieux", Conference on Environnements Informatiques pour l'Apprentissage Humain, pp. 1-12, 2011.

[47] G. Paquette, F. Creiver, and C. Aubin, "Méthode d'ingénierie d'un Systeme d'apprentissage (MISA)", Revue Informations In Cognito, vol. 8, pp. 37–52, 1997.

[48] E. Morin, Seven complex lessons in education for the future, UNESCO, 1999.

[49] P. Gee, What video games have to teach us about learning and literacy, Palgrave Macmillan Trade, 2007, pp. 1-256.