

# Serious Games: A design methodology from concept to end-user

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**Abstract**—Since 2002, serious games have received much attention from industry, government and the research community. However, the large number of definitions available still present limitations in terms of contexts and games classification. Indeed, these definitions exclude certain types of games and do not cover certain contexts where serious games could be deployed. Therefore this paper introduces a shift in the interpretation of serious games, allowing a more flexible definition which can address these limitations. This new definition states that games, including serious games, are actually less of a type of game and more of a process. Consequently, it simplifies the classification of serious games and enables researchers to focus on a more comprehensive methodology rather than on game design. What is more, research on serious games appears fragmented, lacking a complete design methodology and showing little attention to the deployment process. A main objective of this paper is to introduce a better structured methodology which provides a complete approach to serious games. To this end, the methodology gathers techniques and benefits of existing methodologies and frameworks for each process described, with a particular emphasis on the deployment process of games in serious contexts. Furthermore, the methodology is especially designed to be flexible so that it can be consistently applied in any context.

## I. INTRODUCTION

“Serious Games” is becoming an important trend in both academic research and within the games industry, although its definition is subject to debate. There have been studies and research on games for decades [1], nevertheless, the expression “serious games” became popular with the creation of the Serious Games Initiative in 2002 to promote the use of games in various fields such as education, training, health and public policy [2]. The serious games movement also benefited from the launch of the game *America’s Army*, released the same year, and which is now considered to be one of the most famous serious games released so far [3–5]. The growing interest brought to serious games can be explained by two factors. The first factor is the high profit generated by the video game industry. Indeed, according to recent studies, video games generated more than \$20 billion worldwide [6]. The second reason comes from the successful implementation of games in learning environments and business contexts [3,7–9].

However, the definition and the interpretation of the term serious games is not clearly established and according to Sawyer [10], who co-funded the Serious Games Initiative, definitions are too often tailored to fit one particular purpose, thus limiting the extent to which serious games can be applied. Nonetheless, definitions vary greatly. Indeed, Michael [11]

defines serious games as games of which the main purpose is not entertainment or fun, whereas Zyda [12] describes them as mental contests played with a computer, subject to a set of rules, for a purpose which uses entertainment to further various objectives. Serious games are often associated with educational games, training games or simulations. Therefore, a categorisation should be constructed to differentiate serious games from other forms of games or simulations.

Furthermore, Blacklund and Hendrix [13] carried out an extensive literature review to prove the efficiency of serious games in the school environment. They noticed that little research had been conducted on how serious games were actually used in this particular context, and that there may be a bias in the evaluation of the games when the developers are involved in the assessment process. They also raise a series of concerns regarding user acceptance, technical limitations and difficulties with including the games in the curriculum. Moreover, although Blacklund and Hendrix focused on schools, the same issues may apply to businesses.

By shifting existing definitions, it is possible to provide a more flexible interpretation of the term “serious games” that offers several benefits such as:

- 1) Simplifying classification and removing the issues related to existing definitions
- 2) Providing a better distinction between “games” and “serious games”, based upon different sets of features
- 3) Providing a big picture for serious games, and consequently influencing researchers to focus on an overall design methodology rather than designing games
- 4) Removing the existing limitations in terms of context and games

Similarly, to address the limitations of the existing methodologies, it is proposed to develop a new design methodology for serious games which aims to:

- 1) Establish the different processes involved in the implementation of serious games
- 2) Highlight the interdependence between all processes
- 3) Gather the most suitable methodologies and frameworks for each process, and show their respective benefits
- 4) Provide flexible instructions and guidelines. The methodology must be applicable to any type of context

Ultimately, the overall objective of the proposed methodology is to focus less on the design of a prototype of a game and more on the big picture, specifically, the deployment of a game and the context in which it is deployed. Indeed, this aspect of the implementation of serious games has received little attention from researchers but would be beneficial to them as it would simplify, and increase the consistency of, the implementation of serious games.

Thus, section 2 presents a new and flexible interpretation of “serious games”, based upon the various definitions gathered and examples of application. This interpretation is then followed by a justification of the usefulness of serious games. Section 3 describes the overall methodology. It is divided into four subsections respectively dealing with a needs analysis, the game development, the deployment process and the overall assessment. Finally, the conclusion sums up the findings and highlights the limitations of the methodology.

## II. SERIOUS GAMES

### A. Definitions and interpretations

Many researchers have tried to define the expression “serious games”. Interpretations were mainly influenced by observations based upon examples of applications or other authors’ definitions, and in most cases, these interpretations were tailored to support the studies of researchers.

In the publication of their design methodology for serious games, Lacay and Casey simply define the expression serious games by “training applications used in industry”, as opposed to what they call educational gaming or edutainment [14]. In a work-in-progress paper published for a recent conference focused on serious games, the VS Games, De Gloria *et al.* [15] interpret the explanations of Gee [16] to provide a slightly more detailed definition of serious games as “games designed for a primary goal different than from entertainment”. Although Riedel *et al.* [17] seem to focus particularly on simulations for educational and training purposes, they cite a similar definition of serious games from Sawyer [10], which consists of “entertaining games with non-entertainment goals”. Michael and Chen [11] also rephrase the definition by proposing that serious games are “games that do not have entertainment, enjoyment, or fun as their primary purpose”. However, as Susi *et al.* [3] point out, it is difficult to define the term “game” in the first place, and therefore other authors have proposed more detailed interpretations to better address the meaning of the expression. For instance, Zyda [12] successively defines “games”, “video games” and “serious games” and finally formulates “Serious game: a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.”. Backlund and Hendrix [13] reflect on this definition and amend it. For them, serious games are “games that engage the user, and contribute to the achievement of a defined purpose other than pure entertainment”. Susi *et al.* also cite the 2006 I/ITSEC Conference which defined games first and then serious games as games that “overcome a designated problem or deficiency, and provide appropriate feedback to the user about their efforts”.

Finally, Mouahed *et al.* [18] cite Amato who defines serious games as utilities video games and Alvarez who combines aspects of both serious with entertainment.

Despite the wide range of definitions and interpretations available, Sawyer [10] argues that “too often serious games is defined only as that which the definer does”, missing most of the underlying meaning of the expression. Sawyer also shows that it is not possible to build a taxonomy of serious games without building a taxonomy of all existing games. This observation is in accordance with the observations of other authors such as Susi *et al.*, and could help with finding a better definition of serious games. Indeed, if it is not possible to build a taxonomy of serious games without building a taxonomy of all games, then it probably means that the differences between serious games themselves do not provide a sufficient basis to define the expression. Thus, the definition for the concept of serious games may be related to other features, which are not genre or purpose.

In an attempt to define serious games, it can be noticed that most of the definitions embed the term game and use it as a basis upon which is built the actual definition of the expression. Indeed, it can be argued that games are an inseparable component of serious games and thus should be part of the overall definition. But this assumption poses a problem since it would be necessary to redefine the term game as well, which is not the aim of this paper. It can also be observed that “fun” and “entertainment” are often considered to be the original purpose of games. On the contrary, with serious games, this purpose is replaced by a “serious purpose” because the primary objective of serious games is not entertainment. Yet, games are still assimilated to serious games. Can we then still talk about games at all? For Gee [16] and Koster [19], games are fundamentally entertaining and fun, although they may become boring under certain conditions. Trying to determine whether games should be fun and entertaining would lead to further debates, therefore it is simply assumed that games are fun and entertaining by nature, and so are serious games. Consequently, the definitions stressing the fact that serious games are games with another primary purpose than fun or entertainment may not necessarily be suitable.

It is true that serious games are used as tools to further, to support, to enhance and even to improve various fields such as education, training, communication and so on. But traditional games, off-the-shelf video games, board games and other kinds of games can be used for the same purposes. Does this make them serious? Furthermore, some games are especially designed for educational purposes while other games are designed to replicate with more or less accuracy real case scenarios, and yet, they are not called serious games but respectively educational games (edutainment) and simulation games (simulations). Eventually, it can be argued that “serious games” is not so much a type of game, but rather a process involving games to serve a particular purpose which is not the purpose of the game. Moreover, to avoid conflicts with the types of games such as edutainment or simulations, it can also be argued that these types of games have particular features which help in learning, teaching and so on. Nonetheless, these games, are not serious until they are actually deployed in a particular context, such as the classroom or the workplace.

In addition, it can be pointed out that the use of serious

games involves in most cases a stakeholder who is not necessarily a player or who does not need to benefit from the game in the same way as the other players. This is illustrated by the example of the school or any other the learning environment, where the facilitator of learning will make the game available to the students, and supervise the use of the game. This person then becomes a stakeholder, but does not belong to the same group as the student players.

To sum up, the expression “serious games” describes a process initiated in a “serious context” or controlled environment, which serves a “serious purpose” and which is mainly supported by the use of games. The “serious context”, the games and the “serious purpose” can be chosen by the players themselves for their own benefits, or can be chosen by an “external stakeholder”, whose role is to guide players about the use of games within the “serious context” (represented in figure 1).

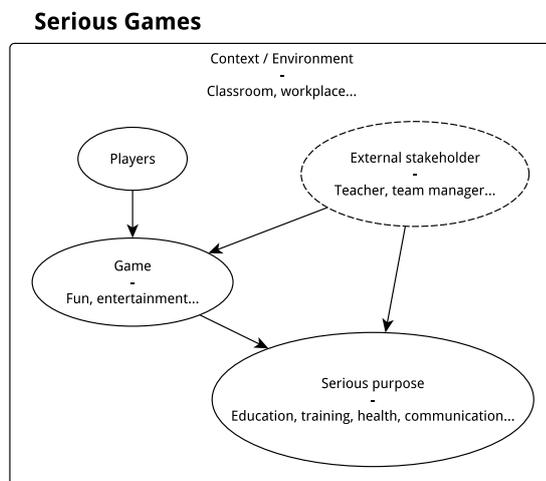


Fig. 1: Interpretation of the expression “Serious Games”

With this definition, all types of games can be used as serious games, no matter whether they were intentionally designed to be entertaining or to serve another purpose, because the expression does not refer to the games themselves any more. Instead, the expression is defined by the context in which these games are used. It also implies that games have a set of fundamental features that will be discussed further in the next section. Finally, this interpretation is flexible enough to be applied to any context.

### B. The benefits of serious games

Despite the fact that the youngest generations have been growing up while technology was developing and video games spreading, and that technology is still evolving very quickly and becoming ubiquitous, two main reasons could be given to justify the use of serious games in real contexts.

The first reason why serious games are generating interest comes from their potential efficiency. Many studies have been conducted to determine the efficiency of games in teaching environments. Connolly *et al.* [20] published a paper in 2012 listing studies showing empirical evidence of the impacts

and outcomes of games, gathering a total of 7392 papers among which 129 met their selection criterion. They concluded that games can have both positive and negative outcomes despite the numerous claims for the negative impact of the games. They also pointed out that this phenomenon is common with other technologies used before games. Furthermore, this observation could be extended to most kinds of technologies and tools since it is possible to misuse or subvert the original purpose of most tools.

Serious games have also been used in businesses, in the military sector and in the health sector. Indeed, in a framework for a classification of serious games in the health sector, Wattanasoontorn *et al.* [21] studied 108 different serious games. The benefits of serious games in this field were illustrated by the research of Alamri *et al.* [22] who implemented a framework based on cloud-games to treat obesity, and concluded that serious games could efficiently help to eliminate the obesity problem.

The other reason is the commercial and financial implications associated with serious games. The video game industry has become extremely lucrative, generating billions of dollars and selling millions of copies [6]. In addition, the fast development of mobile platforms such as mobile phones and the increasing number of units sold open new perspectives on the video games market.

However, video games also present a financial interest for buyers. Indeed, the use of video games may be a cheap option. For instance, in the case of simulations, video games can be a much cheaper alternative to real equipment. The military sector has been using serious games for years, and simulation games allow the creation of large scenarios involving tanks and helicopters without the need of using these vehicles in real conditions. Furthermore, simulation games offer many more possibilities than real training without the associated risks. Indeed, there will be no real consequences if a pilot crashes his helicopter in the game, whereas it could result in loss of lives and important financial expenses in real life.

Finally, serious games can be very cost effective solutions for stakeholders. For instance, the US Army has been successfully using the game *America's Army* as an official recruitment tool for many years [12].

## III. DESIGN METHOD

### A. Preliminary analysis

Game design is not just about writing code and producing the most impressive graphics. Game design has well established rules both in terms of preliminary analysis and implementation. Furthermore, games should comply with a certain number of tacit rules to generate interest amongst players. These rules are even stronger in the case of serious games, since these games will be subject to new constraints by being used in a regulated context to achieve a particular goal initially unrelated to entertainment.

The audience of the games and the serious objectives are dependent on the context in which serious games are implemented. The fundamental rules for game design do not change but a clear understanding of these objectives and the target audience will definitely affect the choice of the type

of game. In fact, it appears that all games are not suited for all purposes. Indeed, as shown by Van Eck [23], the question of addressing the curriculum in the case of game-based learning is balanced between commercially successful games which are engaging but too narrow for learning purposes and games designed especially for these purposes but which don't have such a great appeal for players. The problem can be addressed by combining a series of smaller games which would each address one particular learning objective, such as demonstrated by Buchanan *et al.* [24] in their research on Bloom's taxonomy. This research also justifies the assumption that the type of game has to be carefully chosen. Moreover, Gee insists on the "situated meaning" principle, which means that the meanings of signs come from embodied experiences. The players have to experience situations where the learning process is meaningful. If the player cannot recognise patterns and is unable to understand why he is learning a particular skill in a particular context, then the learning process will be inefficient [16].

The choice of a suitable game for the identified audience can then be confirmed by the comparison of the pedagogic objectives to the games features. Educational frameworks can provide an interesting basis for this task, by decomposing the learning process into several components which can then be associated with a particular type of game, such as the approach of Buchanan *et al.* [24] who used Bloom's taxonomy of educational objectives to propose a consistent set of casual games for cyber security training. However, games can also be decomposed with a great level of granularity into game mechanics. Indeed, different types of games have different features and different game mechanics, that is to say that different games offer different experiences in terms of gameplay, involving different sets of skills. Suttie *et al.* [25] organise the games mechanics into a framework sorting these mechanics by type of thinking skills and associated learning mechanics. Lacay and Casey [14] go further and emphasise the use of game design framework such as the Mechanical Dynamic Aesthetic (MDA) and the Instructional Systems Design (ISD). Based on the guidance of these frameworks, they build a set of "reality requirements" which correspond to the pedagogic objectives previously described and map these requirements onto the game mechanics. They also argue that reality requirements may overlap and be mapped to several game mechanics whereas some game mechanics may be left without reality requirements. In this case, they stress the fact that game mechanics not mapped may have negative outcomes, both in terms of learning objectives and for the development team. Finally, they point out that reviewing the set of game mechanics also enabled them to enhance the fun aspect of some of the gameplay phases.

After mapping real objectives with games mechanics, the level of competence of the "external stakeholder" should be assessed, because it will have a determinant impact on the use of the games for serious purposes. Indeed, this stakeholder could be compared to a referee. Its knowledge of the game, its decisions and its self confidence directly impact the course of the game, its credibility and its authority over players. In the case of serious games, the lack of such qualities could potentially result in counter productive outcomes, defeating the benefits of the games. Bourgonjon *et al.* [26] recently carried out research on game acceptance by secondary school teachers

and pointed out that teachers are the "true change agents of schools in terms of modes of education". Their findings revealed that the use of games to support teaching is not as widespread as the impression that the literature gives, that in some case the attempts to support teaching with the use of other technologies had failed because they were not taking into account teachers' perceptions and that overall, teachers were not really convinced about the virtues of video games in enhancing their own job performance.

To sum up, previous experience of playing or using video games in spare time, a positive image of games, the feeling of usefulness and that games can efficiently support relevant tasks are all factors which positively impact the use of serious games. Therefore, all stakeholders intending to use serious games should possibly have these criteria in order to maximise the success rate of the overall process.

Finally, an analysis of technical requirements should be carried out to ensure that all requirements can be met and that no technical factor can hinder the deployment of the game. Bourgonjon *et al.* mention that the lack of supportive materials, the variable schedules and limited budgets all represent limitations perceived in the educational context as some of the main barriers to the use of games. In a more concrete situation, inappropriate equipment may cause bad user experience, such as the case of the Canadian Army, when they implemented their first "Winged Warrior" exercise. Although the Army worked closely with the developer of the simulation game which was used for the exercise, Roman and Brown [9] report that three successive builds of the game were produced to meet the needs of the Army and address their technical issues. Roman and Brown also briefly describe the technical configuration of the machines used to run the simulation, and it appears clearly that these machines were not suitable for highly demanding applications such as the one which was used for the exercise. Furthermore, the Army had to compromise on the security of their internal network to get better performances while running the exercise. Without these tweaks and compromises, the exercise was "unacceptably slow" and machines were frequently crashing. Finally, the Army noted positive outcomes in the use of the game, and even better results on some aspects than if the simulation had been conducted in real conditions. Nonetheless, these results would not have been achieved if the Army did not have the outstanding support of the developers, who managed to adapt the simulation to the limited hardware.

Table I summarises the main features of the preliminary analysis process.

### B. Development of the game

The implementation of a game for a serious purpose offers two alternatives. The first option is to design the game from scratch while the other option consists of selecting an existing game, called off-the-shelf game, that is to say a game designed by a third party without the original intention to be used as serious game.

Designing games is a very subtle task which requires many skills to achieve it in successful manner. According to Gee [16], at least thirty six fundamental learning principles can be found in video games. Greitzer *et al.* [27] concur on the

TABLE I: Preliminary Analysis

Tasks to be conducted in the first stage of the implementation of serious games
<ul style="list-style-type: none"> <li>- Identify the pedagogic objectives / real requirements</li> <li>- Identify the game mechanics</li> <li>- Map the real requirements to the game mechanics</li> <li>- Ensure that the staff conducting the game has been properly trained</li> <li>- Ensure that the available equipment meets the technical requirements (appropriate hardware, space of the room, light, schedule...)</li> </ul>

fact that games have to turn players into active learners rather than passive learners and that players should adopt a critical approach to the material they are confronted with throughout the game. They also highlight the importance of clear goals in the game. Nevertheless, games present a learning curve [24], therefore games should engage by keeping the player at a manageable level of difficulty [27] while being progressive to remain challenging [28]. Ebner *et al.* [7] add that curiosity is also a good way of maintaining the interest of the player, thus players should be able to get enough information to anticipate events in the game but should sometimes be wrong. Another essential attribute of games mentioned by Gee and Koster [19] is the ability of practicing skills until a level of mastery and the possibility of making mistakes without having to fear consequences in the real world [29]. As a consequence, opportunities should be given to the players to apply the knowledge they acquire to new problems throughout the game. In addition to the repetitive practice and the transfer of knowledge, games should provide feedback to the players to inform them about their performance [7,20,27,30] and offer rewards. Finally, the knowledge should not only be taught by the game but spread across multiple media such as books, forums, websites and so on. These principles incite players to both socialise and extend the boundaries of the learning environment [28,30].

Despite the fact that off-the-shelf games may be more difficult to adapt to match the pedagogic objectives or real requirements, these games have the advantage of being already functional and often offer support either through an official channel such as the website of the developer, or via the unofficial websites of communities dedicated to these games. In addition to these valuable details, we can attribute the success of some of these off-the-shelf games to some of the attributes and features described previously. Therefore, if properly selected, off-the-shelf games have financial and technical advantages, in addition to a pedagogic interest. Furthermore, the availability of these games allows a faster deployment in the relevant context. This was the case for the Canadian Army using the simulation game Steel Beast, but was also possible for educational purposes, such as described by Shultz Colby and Colby [30] in their integration of the online multiplayer game World of Warcraft into a writing course, or even in

physical therapy and physical fitness as reported by Kato [29], with the games Wii Fit, or Dance Dance Revolution.

Table II highlights the important features of a game.

TABLE II: Game design

Second phase of the implementation of a serious game: the choice of a game and the features to include	
Two Options available:	
Off-the-Shelf	Custom Design
Main features:	
<ul style="list-style-type: none"> <li>- Challenging and progressive</li> <li>- Engaging (Active learning)</li> <li>- Ability to practice extensively and repetitively</li> <li>- Ability to apply knowledge to various problems</li> <li>- Provide feedback to players</li> <li>- Resources spread within different places</li> </ul>	

### C. Deploying the game in a specific environment

When it comes to deploying the game selected into the live environment, many researchers focus on user acceptance, in particular with the Technology Acceptance Model (TAM) [26,31], but only a few studies describe a procedure to introduce games into the serious environment. A very important observation made in the literature is that the use of a game disturbs the boundaries between work and play, thus it is necessary to regulate the use of games during working or teaching hours, to prevent a counter-productive effect.

Schultz Colby and Colby [30] who used an online multiplayer game in classrooms suggested that the game is introduced before students start the course. This can be a way to warn the students that the game is being used as a tool to further the learning process rather than a reward, which is not considered to be efficient for this purpose [26]. The introduction is then followed by an assessment of the students' expertise with computers. In classrooms, it appears that there are gaps between students in this field, but this can be used in a positive manner by encouraging the students with the best expertise to share their knowledge with other students. To complete the introduction, the authors stress the fact that students should be introduced to how the game will be exploited to meet the pedagogic objectives. In other words, the introduction maps the real objectives with the game's mechanics. Finally, after this exhaustive introduction, students will be playing the game. Unfortunately, the study does not explicitly describe the role of the teacher at this point, nor the context in which students were playing, whether they were playing in the classroom or at home, if they were playing for a limited amount of time, and if they had to respect particular instructions.

A similar example can be found in the study of Lacasa *et al.* [32] who created workshops based on the use of video games. In this experiment, children from third and fourth

grade, as well as teachers and researchers could take part in the workshops. The sessions were approximately two hours a week and took place over a period of four to five months, in the same classroom with the same teacher. Children were usually playing around 15 minutes in the classroom before playing at home, and then discussing about their gameplay session in class. There is no mention whether the children were playing in groups or individually during classroom sessions. However, Lacasa *et al.* further describe the process by explaining that the discussion occurring after the gameplay sessions had the objective of raising critical questions about the game and the pedagogic objectives, that the answers to these questions would be logged on a blog for further analysis and to enhance the next gaming sessions and to share with other people.

The lesson extracted from these two examples is that video games have to be well regulated in the context they are used, to avoid unproductive play, and the playing sessions can be regular, but should be limited both in terms of time and in terms of context; these gameplay sessions should take place during dedicated time frames, such as workshops. It seems that an introduction to the game being used can help to map the real objectives and the game mechanics. However, these two examples mentioned the use of popular commercial games, and imply that students were playing the game at home, outside the teaching environment. Lacay and Casey [14] raise the concern of having fun under forced conditions and suggest game mechanics to enhance the fun within the game. It can be hypothesised that playing the game used in the teaching environment outside of this environment strengthens the fun aspect of the game and limits the aspect of forced condition, because of a greater freedom toward the game. This would imply that serious games should be used outside of the serious environment to be more efficient.

Finally, although these two examples specifically applied to classrooms, it is worth mentioning that they could well be transposed to other environments. For instance, the use of serious games in a business context could also follow the steps indicated in this section, such as an introduction, an initial assessment to create groups or allocate tasks, and a presentation of the business objectives to meet through the use of the game. The playing sessions could then be organised as part of seminars lead by team managers where the results of the game would be discussed.

Table III summarises the points gathered for the deployment process.

#### D. Assessing the players and the game

The final process of the implementation of serious games is the assessment. Both players and the games used should be assessed. Indeed, it is important to find out whether the use of the game was actually successful and provided benefits or not. It is also essential to assess the game and the way it was used to identify strengths and weaknesses in the methodology and increase the benefits for further use.

Because serious games can be implemented in various domains, the outcomes are highly variable and a general method is not suitable. For each serious game, a set of metrics should be created to assess the various skills and competences involved. In the teaching environment, assessing players could

TABLE III: Deployment

Deployment stage: indications to respect when putting in place the serious game
<ul style="list-style-type: none"> <li>- Follow recommendations of TAM frameworks</li> <li>- Introduce the game before the use <ul style="list-style-type: none"> <li>- Present it as a tool</li> <li>- Introduce the real objectives</li> <li>- Assess players' skills to create work groups or to share knowledge between players</li> </ul> </li> <li>- Regulate the gaming sessions <ul style="list-style-type: none"> <li>- Create dedicated sessions for gaming like any other activities (workshop, seminar...)</li> <li>- Limit the time for playing to prevent counter productive outcome (2 hours a week is suggested)</li> <li>- Interact with the players to provoke critical thinking about the game (discussions during workshops, presentations, meetings...)</li> </ul> </li> <li>- Offer the possibility to play the game outside of the serious context</li> </ul>

be carried out in the same way as in the traditional context where games are not used. However, in the business sector, Bachvarova *et al.* [33] present three different models to achieve this task, the Nonaka's SECI knowledge model, Kirkpatrick's framework and the Return on Investment, accompanied by their respective evaluation tests. Despite the fact that objectives may be different in corporate environment than in classrooms, several of the metrics used in these frameworks are about knowledge and learning, and thus could as well be applied to teaching environment. The authors stress the fact that knowledge is divided between explicit knowledge and tacit knowledge, and that the latter is the most important among the two but is also the more difficult to measure. Therefore, the authors emphasise evaluating the transfer of knowledge by measuring the level of social interaction. Other skills can be assessed by collecting data as statistics via built-in game mechanisms, via questionnaire and surveys filled by players, or by interviewing players.

Games can finally be evaluated by putting data collected in correlation with the game mechanics identified and exploited. Nevertheless, it is also fundamental to collected feedback from the players in order to maintain an acceptable level of "playability". Most studies suggest the use of pre and post testing to collect this data, often implemented by questionnaires and surveys [7,33].

Table IV proposes various approach for assessing players and evaluating games.

## IV. CONCLUSION

Games, and video games in particular, have been used in various fields for several years now and researchers are trying to prove the validity of this technology as a supporting tool for

TABLE IV: Assessment

<p>Recommendations for the assessment of the game and the players, throughout all stages of the use of the serious game</p>
<ul style="list-style-type: none"> <li>- Assess players and games</li> <li>- Define relevant metrics</li> <li>- Put in place pre and post testing             <ul style="list-style-type: none"> <li>- Use questionnaires or surveys</li> <li>- Collect data via game statistics</li> <li>- Collect players feedback</li> </ul> </li> </ul> <p>Other assessment options are possible depending on the context:</p> <ul style="list-style-type: none"> <li>- Tests, essays, presentations...</li> <li>- Return on Investment, Nonaka's SECI knowledge model, Kirkpatrick's framework...</li> </ul>

learning, training, and so on. This growing interest in games for other purposes than entertainment has led to the creation of the term serious games. However, despite the fact that the expression was formally introduced in 2002, its definition and interpretation have still not been clearly established. Based upon the current research, it has been suggested to reconsider the interpretation of the expression serious games and to define it as a process with a serious purpose, supported by the use of games.

This paper establishes that serious games is less of a type of game and more of a process. Thus, this interpretation defines new characteristics for each expression and simplifies the classification of both games and serious games. Additionally, it removes restrictions and limitations in terms of games and contexts and re-focuses researchers on a complete process rather than game design only.

Many hypotheses have been formulated about the efficiency of games, and more particularly video games in the learning and business environments, and although it has been claimed that games are not suitable for these purposes, many studies have actually shown encouraging results. In fact, many studies describe the various steps necessary to implement serious games. Nevertheless, there seems to be a lack of research on how serious games are actually deployed in context, and the research does not really often focus on a complete design methodology from the need analysis to the collection of feedback.

Therefore, the objective of this paper was to combine all the various elements necessary to the successful implementation of serious games in a consistent manner and to highlight the deployment process. A secondary objective was to produce a flexible methodology to avoid context dependency. As a result, the methodology can be applied to as many fields as possible without limitations. This aspect is particularly useful as researchers from different fields will be able to apply a common methodology and thus contribute to the development

and reinforcement of the methodology.

Furthermore, the methodology emphasises the deployment process by making it one of the four main processes. A few empirical observations can be found in the literature and can possibly constitute guidelines for the deployment process, but no specific protocol or methodology has been established so far. Nonetheless, this area, which has received little attention from researchers, actually has a great impact on the probability of success in the implementation of serious games, and therefore would be very beneficial for the future of serious games.

Finally, this work highlights some gaps in the research on serious games and aims to encourage the research community to develop a methodical framework on how to deploy games in serious environments.

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