Simplifying the validation and application of games with Simva

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Abstract. The suitability of games for learning has been proven for many years. However, effective application of games in education requires two important stages: their initial validation, and their later use in the classroom. Serious games should be validated prior to exploitation to prove their efficacy and usefulness as tools for teachers, via larger experiments that include data collection, either from in-game interactions or from external questionnaires; this, in turn, requires dealing with data privacy regulations and informed consent. Once validated, serious games can then be applied in educational environments, where their effective application is closely linked to the tools and preparation available to the teachers and educators that use them. In this paper, we revise the steps and considerations that need to be dealt with both when conducting experiments with games and, later, when applying them as part of teaching in educational scenarios. For both these stages, we provide guidance and recommendations to simplify stakeholders' tasks, including the use of the tool *Simva*, which simplifies the management of users, questionnaires, privacy, data collection, and storage.

Keywords: Serious Games, Games Validation, Game-Based Learning, Learning Analytics, e-Learning.

1 Introduction

The application of Game-Based Learning (GBL) has greatly increased in the last years, as many studies have proven the benefits of applying games in educational settings [1]. The interactive nature of games increases the engagement of students in learning activities, motivating them to progress and complete the in-game tasks [2]. This way, students further improve their learning as a consequence of their gameplay. The benefits of games, and in particular of their application in education, have attracted the attention of many stakeholders: from researchers, game developers and designers trying to create games that are effective tools for learning, to teachers, educators and institutions more increasingly willing to apply games as part of their teaching

activities. These stakeholders are involved on different parts of the application of games for learning, and consequently face very different issues when carrying out these experiments or applications with games.

1.1 Issues for researchers, game designers and developers

On the one hand, researchers, game designers and developers are trying to promote the application of games in education by conducting experiments to establish their effectiveness and usefulness as a tool for teachers. For this and other purposes, experiments usually include the collection of interactions from students' gameplays. For instance, the authors of [3] provide a practical guide of the use of games in experiments, including the choice of game, event coding, data determination, participants and data collection. These experiments applying games have multiple benefits but also have high costs in terms of time and effort, both during preparation and their later execution. These issues need to be dealt with by whoever oversees the application: commonly game designers, game developers, or researchers. On research applications, these issues are dealt by researchers themselves who do not tend to involve teachers or educators in the process. This way, the researchers conducting these studies take an active role in the use of games, preventing teachers from dealing with these issues. While this simplifies teachers' tasks on these applications, it can also complicate their work in the common case when they are later going to apply the same games on their own.

These experiments generally include the collection of some in-game interaction data from players. The field of Learning Analytics (LA) [4], which has greatly increased since 2011 [5], covers the collection and analysis of data from learning activities to understand and improve learners' processes and contexts. Building up from LA and focusing on serious games, the field of Game Learning Analytics (GLA) extends this to the collection, analysis and display of information on the activities and progress of player-learners. The applications of GLA are wide and varied [6], including, among others, assessment and student profiling. These applications can be used to validate game design, or to gain insights that would otherwise be much harder to obtain [7].

1.2 Issues for teachers and institutions

On the other hand, teachers, educators and institutions need effective tools that simplify the application of games in their classrooms. In fact, teachers still find it difficult to integrate this learning approach into their regular practice [8], partly because real, long-term applications of games, necessary need to be managed by teachers on their own with only minimal external support. However, teachers or educators are generally not experts in dealing with software or hardware requirements. Therefore, simplifying teachers' tasks on these real-setting scenarios becomes a crucial step towards the advance of game-based learning.

Authors have identified this issue and try to propose actions to help teachers adopt games. For instance, the work of [9] presents a framework to model the process of teachers' adoption of games. According to this framework, teachers (1) become aware

of the innovation to be introduced, (2) focus on adoption and seek more information, (3) engage in activities to measure pros/cons of the innovation and decide whether to include it or not, (4) introduce the innovation and finally, (5) obtain feedback to reinforce their choice. On this work, authors also pointed out several recommendations for teachers to adequately adopt games as part of their teaching practice, including the appropriation of the game by experiencing the activity before taking it to their students. They also found out that rejection of the activity was motivated by fears and issues such as a perceived lack of advantage compared to their previous teaching activity, misuse of the game, or fear of losing control of their students.

The focus of our work is on educational videogames or serious games in general. However, commercial videogames may also be used in education. The study of [10] presents the advantages and disadvantages of using commercial videogames in experiments. Among the advantages they point out, the following are especially significant: ecological validity, lack of implementation times and/or external influence on the implementation, and reproducibility; while disadvantages include that modifications in the games may be difficult or even impossible to conduct, the specificity of the hardware used, and the difficulty of finding a game that is a good fit for a given set of purposes and constraints.

On this paper we revise the considerations that need to be taken into account when (1) conducting experiments with games in real educational scenarios and (2) applying games as part of teaching. We provide guidelines for both researchers or game developers/designers and teachers for both scenarios. These guidelines are presented along with the tool Simva, which simplifies some of the most costly parts of experiments and game applications including questionnaires and data collection, storage, or participants' management. The rest of this paper is structured as follows: Section 2 describes considerations when conducting experiments, including the GDPR regulation and the use of informed consents. Section 3 describes considerations for teachers when applying games in their classes. Section 4 presents Simva and its features to simplify experiments for both previous scenarios. Finally, Section 5 presents the conclusions of our work.

2 Considerations when conducting experiments

Experiments to validate games or apply them in educational settings by external researchers or game developers/designers must deal with several issues at the different phases of the experiments. Even if teachers are present in those experiments, most of these issues will generally fall out of scope of the work of teachers, and should therefore be managed by the experimenters:

1. **Before the experiments**: privacy regulations need to be addressed carefully, including applicable data privacy regulations, such as the General Data Protection Regulation (GDPR) [11]. To ensure their adequate application, anonymization or pseudo-anonymization techniques will commonly need to be applied to the data collected. This requires an anonymization system to be clearly defined and established. Informed consent may also be required in specific contexts, and their char-

acteristics will depend heavily on the type of participants (e.g. minors) and/or the nature of the data to be gathered.
2. **During the experiments**: collection and storage of the data of the experiments need to be dealt with. For this, a clearly established system needs to be defined, including hardware and software requirements. If different data sources are collected for the same user, a way to link all the information collected from the same user must be supplied. If a feedback system is included to display information on the progress of participants while the activity is being carried out, this system should not hinder privacy.
3. **After the experiments**: once the experiments are completed, some offline aggregated information could provide information of interest for the game developers/designers or researchers. This feedback of the experiences could be provided via aggregated visualizations or with some more complex techniques such as data mining. This data analysis could also be simplified if the system that collects the data does so in a standard format and allows for a user-friendly export of the data. If data is going to be reused or maintained, it should also be defined (e.g. in the informed consent).

In the case of research applications, the previous steps should be guided by an experimental design which defines the purpose of the application and how all issues are going to be dealt with. This experimental design would be defined by researchers, which must also receive informed consent for data collection by the institution where the experiments are going to be conducted (e.g. school). The following subsections detail two of the major issues that need to be dealt with before the experiments, including the GDPR and the informed consents. To this end, Simva can also help to simplify many parts of the issues that arise. These features that Simva includes and can be helpful for researchers, game designers and developers when carrying out these type of experiments are detail in Section 4.

2.1 GDPR

Before conducting the experiments, several requirements have to consider including privacy, and legal regulations that may affect how data can and should be collected and stored. These regulations will typically differ depending on the type of users participating in the studies (e.g. minors, participants with intellectual disabilities) and the specific characteristics of the studies, including the type of data to be collected, the collection and storage system.

The new General Data Protection Regulation (GDPR) defines personal data as “any information that relates to an identified or identifiable living individual” [12]. This includes the scenarios where different pieces of information joint together can be related to an individual as well as cases of using pseudo-anonymization. If individuals can not be identified from some data, that data is no longer considered as personal data. It is important to notice that GDPR protects all personal data collected regardless of the system used to store the data (e.g. paper, computer) or to process it (manually or automatically).

2.2 Informed consent

Informed consent is a procedure to inform and gain permission from participants in a study to collect some personal data prior to the collection [13]. Informed consents are commonly used on the medical domain, but are applied on a broader set of fields. They commonly present the purpose of the collection of the information, as well as its implications and consequences. Usually, informed consents are provided directly to the person data is going to be collected from. However, for specific participants, such as minors or people with certain disabilities, informed consents can be collected from their parents of legal guardians. Although some studies have debated whether children have the capacity to give consent by themselves, the most widely accepted and recommended option is that approval is given by some other responsible adult (e.g. parents or teachers) [14].

The use of informed consents has been required in recent research such as the latest projects of the European Commission. For FP7 projects (years 2007-2013), informed consents were required when participants were minors, patients, immigrants or incapacitated, or when the studies collected any personal data [15]. For the case of minors, those guidelines requested the informed consent of parents or legal representatives, but also the consent of children, with information sheets created according to the age of the participants. For the H2020 program (years 2014-2020), guidelines stated the information informed consents should include (aim of the research, methods, how data will be collected, protected and if it is later going to be reused or destroyed) [16].

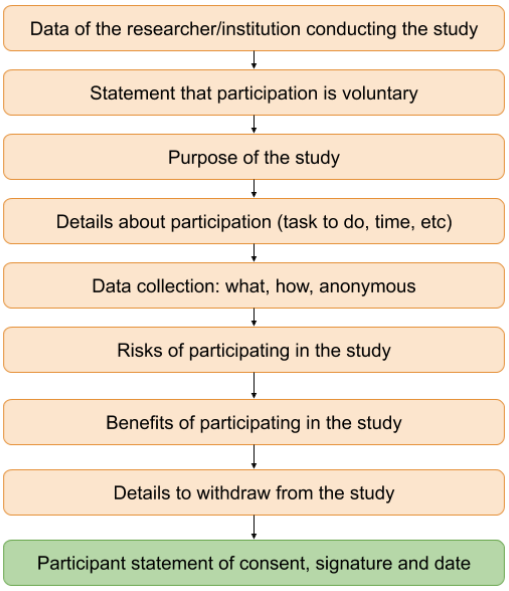

Fig. 1. Informed consent guideline points.

For children or people unable to give consent (e.g. mental disabilities), consent is to be obtained from their legally authorized representative.

Fig. 1 details some of the issues informed consents should include, as a guideline for researchers creating informed consents. Notice that this is not an exhaustive list, depending on the study, some of this points will not be required (e.g. there may be no benefits or risks) and others may be included. Their order is also optional.

For children, it is recommended that the statement of consent is given by parents or legal representatives. However, as stated before, it could also be interesting to obtain some type of consent by the children themselves if possible, in some terms adapted to their age so they can understand at least the purpose of the study they are going to take part in.

3 Considerations for teachers applying games

The application of games in real scenarios by teachers or educators also includes dealing with several issues at the different stages of the application. Among the steps that teachers need to take into account, we include:

1. **Before the application**: first of all, teachers will have to choose an adequate game that fits the curricula or provides a useful experience for their students. Before taking the chosen game to students, it is recommended that teachers play the game so they have the complete experience and fully understand the tasks that their students are going to be asked to do. If there is any complementary material available (e.g. users' guide), it is also highly recommended that teachers fully read and understand it as it may provide additional context and information about the game and its goals and design. Additionally, teachers may want to assess their students using some external questionnaires. For these cases, the questionnaires should be defined and prepared before the game is played and handed to students at the appropriate times (before and/or after the application). The questionnaires may be handled on paper; on Section 4, we present a simpler way to deal with questionnaires using Simva.
2. **During the application**: the previous preparation of teachers by playing the game and/or reading any complementary material will simplify their tasks while students are playing as they will be more aware of the steps they have to do. Additionally, for teachers to keep control of the class and of their students' progress, some way of feedback or system displaying information would be highly welcomed. For instance, if an Analytics System is receiving the in-game interaction data, teachers will be able to keep track of what each student/player is doing (e.g. progress, actions, paths, performance metrics). This will also allow teachers to perform interventions during the gameplays: they may help students getting stuck or provide additional material for advanced students.
3. **After the application**: if aggregated data is provided to teachers (either as global visualizations or as aggregated metrics or reports), this information could be used by teachers as means of players' assessment. Depending on the game content and purpose, a debriefing session may be recommended to revise the content included

in the game and even to relate it to the curricula to increase understanding and help students transfer the knowledge learned in the game.

For both previously-described scenarios (carrying out experiments to validate games and effectively applying games in education), the stakeholders involved can benefit of the use of Simva, a tool to simplify scientific validation of games and in general experiments using games. The next section details the features that Simva provides.

4 Simva

Simva is a tool designed to simplify the scientific validation of serious games [17], as well as the assessment of students playing them, both tasks commonly measured via comparison of pre-tests with post-tests. Simva has been already tested on different scenarios to validate games, compare different game versions or carry out recall experiments [18].

Simva includes many features that can help to simplify both researchers, game designers or game developers' tasks when conducting experiments with games on educational settings; and teachers' tasks when applying games in their classes. As part of these applications, Simva can help the different stakeholders to deal with issues including: students' management, students' anonymization, control of access, level of completion, and data storage and management. Details of how Simva helps to deal with those issues are provided below.

Student management. Simva works with classes of students, to which then provides anonymization features and simplifies assigning questionnaires. Classes of students can be created in Simva providing the number of students per class. The created classes are then kept in Simva where questionnaires can be linked to classes.

Student anonymization. With class creation, Simva provides the pseudo-anonymous 4-letter random tokens, one per student. These tokens are provided as doc and pdf files to be printed before used. On these files, each token can be cut off to be handled to students before the experiments. For each students, the token is repeated four times, so they can be re-used in several experiments. Additionally, next to each different token, a blank space is available so teachers can write down on their printed papers the name of the student using each token. This way, teachers can relate the information of each token to the student it belongs to, while ensuring privacy as no personal data is input into the system. The bottom-part of **Fig. 2** displays an example class list with the anonymous tokens provided for students.

Access control. Games can be configured to require the anonymous token for players to access the game. If so, the game then checks that there is a class created in Simva where the introduced token is included. When games are configured to include ques-

tionnaires in Simva, students will not be allowed to start a questionnaire unless their access token is configured for that questionnaire. Additionally, players will not be able to access the game until the questionnaire prior to the gameplay is completed. This check is also done via Simva.

Level of completion. While experiments are in play, the class view in Simva provides

Clase ElCaton 1A

Code	Conectado (Pre/Post/Other)			
GYRJ	FINISHED	FINISHED	FINISHED	TRACES
WEFF	FINISHED	FINISHED	STARTED	TRACES
YEYT	FINISHED	NOT FOUND	NOT FOUND	TRACES
ZMBL	FINISHED	STARTED	NOT FOUND	TRACES
WSFJ	FINISHED	FINISHED	STARTED	TRACES
MLBT	FINISHED	NOT FOUND	STARTED	TRACES
KGMV	FINISHED	NOT FOUND	STARTED	TRACES
IBAH	FINISHED	FINISHED	FINISHED	TRACES

Clase ElCaton 1A:					
No.	Nombre	Código			
1		GYRJ	GYRJ	GYRJ	GYRJ
2		WEFF	WEFF	WEFF	WEFF
3		YEYT	YEYT	YEYT	YEYT
4		ZMBL	ZMBL	ZMBL	ZMBL
5		WSFJ	WSFJ	WSFJ	WSFJ
6		MLBT	MLBT	MLBT	MLBT
7		KGMV	KGMV	KGMV	KGMV
8		IBAH	IBAH	IBAH	IBAH

Fig. 2. Simva screenshots: top part, class view depicting students' anonymous tokens, questionnaires status and traces collected; bottom part, list of students with tokens to be cut and handed to students.

additional information for stakeholders to keep track of players' progress. On this class view, Simva displays the questionnaires status for each player: started, finished or not configured. This status is displayed for all questionnaires configured (currently a maximum of three questionnaires are available: a pre-test, a post-test and an additional questionnaire). Simva also displays whether interaction data (traces) has been collected. The top part of **Fig. 2** displays an examples class in Simva where the three questionnaires are configured for the class. For each student (column "Code" on the left-part), we can see the status of all three questionnaires ("finished", "started" or "not found"). The right-most column provides the traces collected.

Data storage and management. Both responses to all configured questionnaires as well as game learning analytics interaction data are sent by the game to and collected in Simva. All this information is identified by the anonymous token introduced by users when accessing the game, so the data is stored in Simva linked to the user token it corresponds to. After the experiments have been completed, stakeholders can download all collected data from Simva, automatically linked from each student together.

5 Conclusions

To promote the application of games in education, both of the major stages must be simplified: first, the experiments carried out to validate and prove the efficacy of these games as learning tools; and then, the teacher's tasks when applying games on their own. For the first stage, researchers or game designers and developers can benefit from automated support that simplifies compliance with data privacy regulations such as the GDPR, and the gathering of informed consent in experiments. In this paper we have provided guidelines for both, and described the use of a tool to greatly simplify the adoption of these guidelines through partial automation: Simva.

Once games are validated as effective, we enter a second stage, where teachers and educators apply them effectively in their classrooms. This, again, requires tools and preparation to manage the game application on their own. For this purpose, we have provided guidelines on the steps that teachers should take before, during and after the application of games. In our experience, these guidelines make teachers more comfortable with the application of games, making them aware of their students' actions and progress while they are playing, and providing them tools to conduct activities after the game that can help students relate the content with the curricula.

Both stages can benefit from the use of Simva. Although the main goal of the tool is to simplify the scientific validation of games, it can also help in everyday classroom uses of serious games by teachers. Simva helps in the questionnaires' management, data collection, users' management and privacy issues.

Future lines of work include testing Simva in more experiments, determining the relative effectiveness of the tool for different stakeholders in each of their tasks, and identifying areas of improvement to further simplify the application of games in educational scenarios.

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