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DEVELOPMENT ARTICLE

Developing game-like simulations to formalize tacit procedural knowledge: the ONT experience

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Abstract The exceptional success achieved by the Spanish National Transplant Organization (ONT) in recent years has made other countries highly interested in following this organization's methodologies. A good training program is one of the key elements of the ONT. Until 2012, the ONT training program was a paper-based case teaching method, and the small number of ONT experts limited the audience. In an attempt to improve and increase the attendees in this program, a game-like simulation was developed to represent transplant management procedural knowledge. To maximize the educational value, this game-like simulation was based on representative teaching cases to help students practice with different real situations and different levels of complexity in a risk-free environment. This study presents how an iterative game development methodology has been applied to evolve from a paper-based case teaching method to a game-like simulation, with a special focus on the efforts made to include the ONT experts' tacit procedural knowledge in the simulation. Apart from increasing the number of students who can access the ONT training, this game-like simulation also helped to achieve a more detailed formalization of transplant management as well as a more comprehensive systematization of a set of relevant teaching cases.

Keywords Screen-based simulation · Educational games · Tacit knowledge · Medical procedures · Case-based teaching

Abbreviations
ONT Spanish National Transplant Organization

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Introduction

After intense debate, serious games have emerged as a promising technology for education that could soon be ready for wide adoption (Hwang and Wu 2012; Johnson et al. 2013). However, to be deployed mainstream, the scalability of serious games must be improved, because the development of serious games is still a costly and complex process, which limits the situations in which game-based learning (GBL) can be applied (Dede 2009; FAS 2006).

Such a lack of scalability is partly due to the difficulty of capturing, formalizing and adapting the domain knowledge to fit into a video game design. Highly specialized knowledge could be tacit [i.e., knowledge that is not easily accessible to introspection via any elicitation technique (Blandford and Rugg 2002)]. It can be difficult to formalize this type of knowledge, especially in healthcare, where highly specialized and complex procedures constitute a considerable part of the domain knowledge and must be executed with precision to prevent patient damage. Moreover, these procedures are difficult to understand for game developers, who rarely have the medical expertise that is required (Friedrich and Poll 2007; Heiberg Engel 2008; Kothari et al. 2012).

The idea of using serious games, simulations and other content of a similar nature in healthcare education is not new, and several successful case studies are available (Arnab et al. 2012; Rosser et al. 2007). In these experiences, domain experts and game developers must necessarily establish a development methodology that is effective in capturing and transferring (at least partially) the domain knowledge to a simulation. Nevertheless, in these experiences, emphasis tends to be placed on the presentation of the results and discussion of the benefits obtained rather than on the development methodology that is followed.

Here, we attempt to fill this gap by describing the methodology that is followed to design and develop educational game-based content. Therefore, the purpose of this study is not to report on the learning gain or the impact of using the software developed in the learning process, but instead, the goal is to describe a development methodology that could help other developers and researchers produce educational games and collaborate with domain experts more efficiently.

We have applied the methodology to transform part of the Spanish National Transplant Organization (ONT)s technical know-how into game-based educational content. ONT is the institution that is responsible for coordinating organ deceased donation in Spain. The organ deceased donation process refers to all of the tasks that are taken since a hospital transplant coordinator considers a patient to be a potential donor until the suitable organs are transplanted to a recipient. In recent years, ONT has achieved the highest rates of organ deceased donation per country, becoming a world-leading institution (Domínguez-Gil et al. 2011; Matesanz et al. 2009, 2011; Matesanz-Acedos 2009; Scandroglio et al. 2011). As a result, the ONT organizational system (known as the Spanish Model on Organ Donation and Transplantation) is highly appreciated by other international organizations, for whom ONT provides several training courses every year. Having part of this workflow captured into game-based software facilitates dissemination to a wider audience. A second benefit is the improvement of the internal knowledge systematization and standardization processes of the ONT.

We define the software developed as *game-like simulations*: simulation environments that are enhanced with several game elements (Moreno-ger et al. 2008). The software is in the first place a highly interactive, 2-D point-and-click simulation environment that allows students to rehearse a specific procedure in a safe and cost-effective world. These game-like simulations are based on cases that are composed by relevant educational situations and not on a physical simulation model. Then, the process is *gamified*, adding elements that are frequently used in games, such as narrative underpinnings and the use of a score and achievements to foster competition. While the game component is much less important than the simulation component, the simulation helps to deliver a more engaging student experience while preserving the cost efficiency.

The remainder of this study is structured as follows. We first explain the process of organ deceased donation and the ONTs instructional approach. We then provide an overview of the simulation developed and the development methodology followed to develop it. We lastly discuss the strengths and weaknesses of this approach and present conclusions and future work.

Background: the ONT

The process of organ deceased donation

The organ deceased donation process covers multiple tasks that require an extremely efficient interaction among several stakeholders. To maximize a rapid response and efficiency, the process is distributed at two levels: the hospital level and the supra-hospital level. The hospital level covers the identification and maintenance of potential donors: brain-dead patients who could meet the organ donation criteria. A hospital transplant coordinator is appointed for each Spanish hospital to coordinate these tasks. Hospital transplant coordinators interact with the ONT, which is the single entity that is responsible for cross-hospital coordination (at the supra-hospital level). The main steps covered at the supra-hospital level are the organ and donor evaluation and the subsequent organ allocation and transportation processes (including all of the logistical aspects). Figure 1 provides an overview of the whole process.

The process starts with a hospital transplant coordinator notifying to ONT that a potential donor has been identified. Then, ONT nursing personnel ensure that all of the information that is needed to evaluate donor and organ suitability has been provided. Afterward, the ONT determines what individual organs are to be offered to what transplant teams (one or many) across the national territory following complex allocation criteria. ONT contacts the selected teams and provides them with all of the information that is required. Teams then decide on the acceptance or rejection of the organ and the subsequent

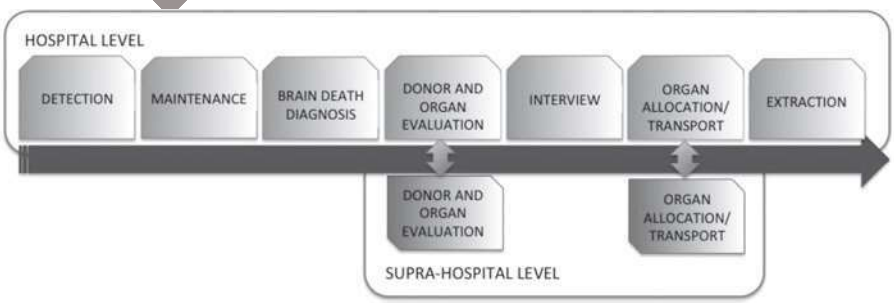

Fig. 1 Process of organ deceased donation

transplantation. Once a team accepts the offer of an organ, ONT organizes the transport and logistics of the organ.

The ONT instructional approach

Since its creation in 1984, ONT has trained over 14,000 health professionals worldwide through several programs. For the sake of simplicity, in this study, we categorize these training programs into two groups: internal programs and external programs. Internal programs target new ONT staff. External programs are open to different professionals who are interested in the areas where ONT is involved.

A typical internal training program lasts 6 months and follows a master-apprentice approach. During these 6 months, the novice nurse works under the supervision of an experienced nurse to learn the procedures and the know-how of the ONT. After this period, the nurse achieves mastery through practice and observation. This process is necessary to acquire the tacit knowledge that is required to address the very diverse cases that could appear in the process of organ deceased donation.

External programs are organized year-round on four different editions in Spain and target the health professionals (e.g., hospital transplant coordinators). The attendees are provided with an in-depth overview of the ONT model on supra-hospital coordination of organ deceased donation. Until 2012, ONT used a traditional case-based teaching methodology (Dolmans and Gijbels 2013). Case-based teaching has already been proved to be an effective method of teaching (Irby 1994; Srinivasan et al. 2007; Strobel and van Barneveld 2009) that promotes critical thinking and decision-making skills (Chan et al. 2008; Kim et al. 2006), which turns students into active agents of their own learning (Barell 2010).

This approach has two significant limitations. First, the approach was instructor-dependent because ONT lacked a standardized set of training cases that were agreed upon by all of the ONT experts involved in the training. As a result, the teaching cases were chosen by the trainers prior to each course based on their own criteria and experience. Second, the instruction was resource consuming, because it always required involving several of the most experienced nurses of the ONT. Having only 14 people as a workforce, it was necessary for ONT to optimize the instruction.

Through the development of a game-like simulation that the ONT aimed to address, there were (at least partially) the two aforementioned limitations plus the known benefits of learning simulations: ubiquity (allow the students to practice anyplace), risk-free learning, and learning by trial-and-error, among others (Aldrich 2004).

Overview of the game-like simulation developed

The game-like simulation that was produced set up a player at the ONT headquarters where the nursing personnel perform all of the supra-hospital tasks of the process of organ deceased donation. The main scenario of the simulation takes place in this central office (Fig. 2a). The player takes on the role of a transplant coordinator (the main character in the game-like simulation). Other characters also participate, for example, the hospital coordinator of a Spanish hospital (Fig. 2b shows the hospital coordinator character calling the ONT). The player must know the goal of the game-like simulation (i.e., to evaluate all of the organs of a potential donor) and what rules to follow, which can be found at any time in the main scene of the simulation.

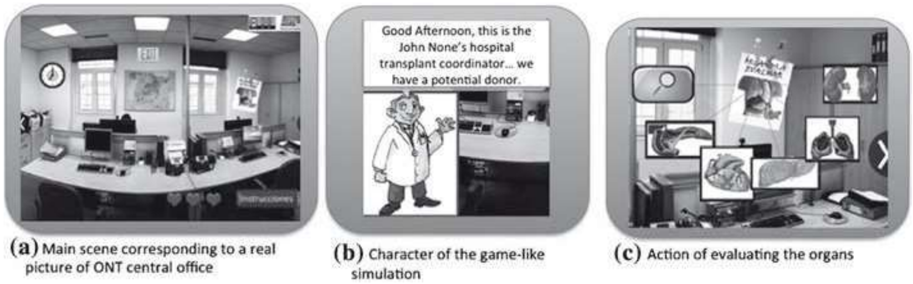

Fig. 2 Different screenshots of the game-like simulation

The player can explore the scene by moving the mouse around to discover the interactive objects. By clicking on any of these objects, the actions that are available for the object appear (in Fig. 2c, the player is performing the organ evaluation action). In this simulation, the player can interact with the phone (to answer or make a phone call), the fax (to obtain faxes from hospital coordinators with different information), the donor information page (to study the information on a potential donor) and the evaluation page (to evaluate the suitability of the organs).

From case-based teaching to game-like simulation

The methodology followed to produce the game-like simulation is built on the principles of agile software development. This methodology is iterative-based, provides a rapid response to changes and fosters communication between heterogeneous working groups (in this context, 'iteration' refers to executing a specific set of instructions or processes a given number of times or until a specified result is obtained). The methodology supports the efficient capture of tacit knowledge by empowering communication between domain experts and game designers, who are the main intervenient roles (in our case, the domain experts are the ONT medical and nursery personnel).

The methodology followed is represented graphically in Fig. 3. In each loop, domain experts and game designers perform tasks that are related to the following four processes: Specification, Game Design, Simulation Development and Quality Assurance. These four processes are dependent on each other, and the workload allocated to each process varies depending on the number of iterations. In the early iterations, the specification and game design activities are more relevant, and in the last iterations, the implementation and quality assurance are more demanding.

In the next subsections, each process is described in detail. Subsections have a common format: first, a general overview of the process is provided. Second, we provide specific details on how the methodology was applied in the development of the ONT simulation.

Specification

The final objective of this process is to obtain a detailed specification document that describes the next aspects: the characteristics of the intended target audience, the know-how related to the medical procedure that the game-like simulation must cover and how it is going to be represented, the environment and settings that the game-like simulation is

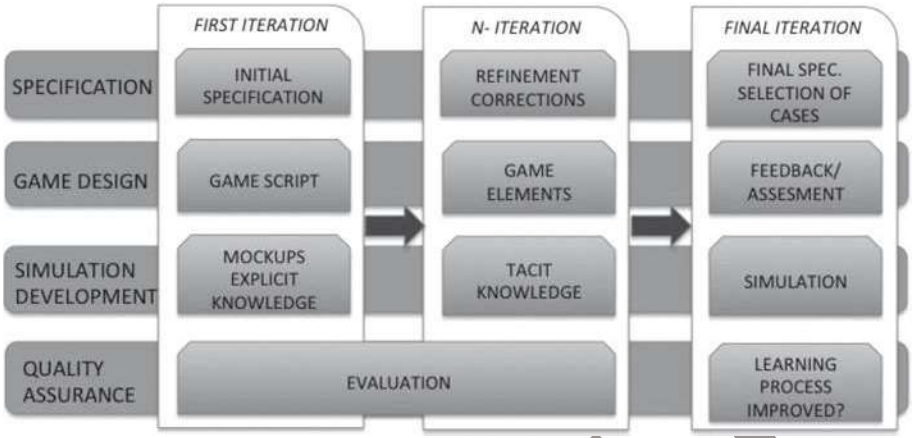

Fig. 3 Iterative methodology

intended to use and any other information that is needed to formalize the medical procedure. This process also facilitates the systematization of the teaching cases.

This detailed description is the result of achieving an agreed-upon project specification among the different experts that take part. Tight collaboration between domain experts and game designers is essential for the success of the simulation.

Another output derived from this activity is the shared vocabulary and knowledge that is related to the project, which are meaningful for every stakeholder. This output facilitates communication among experts with different backgrounds (medical and computer science). Specification tasks must not be overlooked. Any misunderstood or unclear concepts can lead to inaccurate procedure representations with the consequent loss of time and effort.

ONT transplant management specification

Our specification process started with an analysis of the documentation that was provided by the medical experts, which is related to the medical procedure. However, these documents lacked the level of detail that is needed to design a game-like simulation, because these procedures are targeted to staff with medical background. For example, a much more detailed description was needed to define the interactions of the game-like simulation or the common errors or imprecisions that are considered to increase its educational value.

Consequently, we performed several interviews with the domain experts to better understand the process and to capture the necessary level of detail. This communication was difficult, as domain experts tended to overlook information that is not obvious for non-domain experts.

One of the most important aspects of our specification process was the selection of the final teaching cases to include in the game-like simulation, which was conducted following some of the ideas proposed in (Kim et al. 2006). These teaching cases were created from a set of existing potential and actual donors (Gordon et al. 2004) that were relevant.

Domain experts classified, modified and even mixed those cases to meet the educational objectives (Khan 2007). We placed emphasis on selecting cases that were not obvious to analyze or that challenged the student in some special way. The final aim is to assure that a student acquires, after practicing with these selected cases, sufficient knowledge to be able to evaluate the organ suitability of most of the donors.

In a second iteration, the game designers also reviewed the cases that were selected, to ensure that the combination made a good game-like simulation. In this sense, the following were the main criteria that were applied: (1) sequential ordering of cases according to difficulty; (2) adequacy for novice and intermediate players; (3) inclusion of unusual cases; (4) consistency of the data provided, and (5) likeliness with real cases.

As a result, ten significant teaching cases were selected. These cases were further confirmed and were enriched if necessary or filtered out during the quality assurance process. Additionally, to comply with Spanish regulations on personal confidentiality, any personal or sensitive data were deleted or modified from the cases.

Eventually, two outputs of the specification process were obtained, a specification document and an agreed-upon vocabulary. We provide an excerpt of the document in Fig. 4. The shared vocabulary included medical concepts such as hospital level, supra-hospital level or potential donor and game concepts, such as scenario, character or score.

Game design

The final output of this process is a game script that represents the transformation of the specification document to the game design elements. To accomplish this objective, the game designer must understand the procedure, draw the storyboard of the game-like simulation and check that it provides the appropriate entertainment and educational value. The game designer must know how to integrate into the design skills, knowledge and

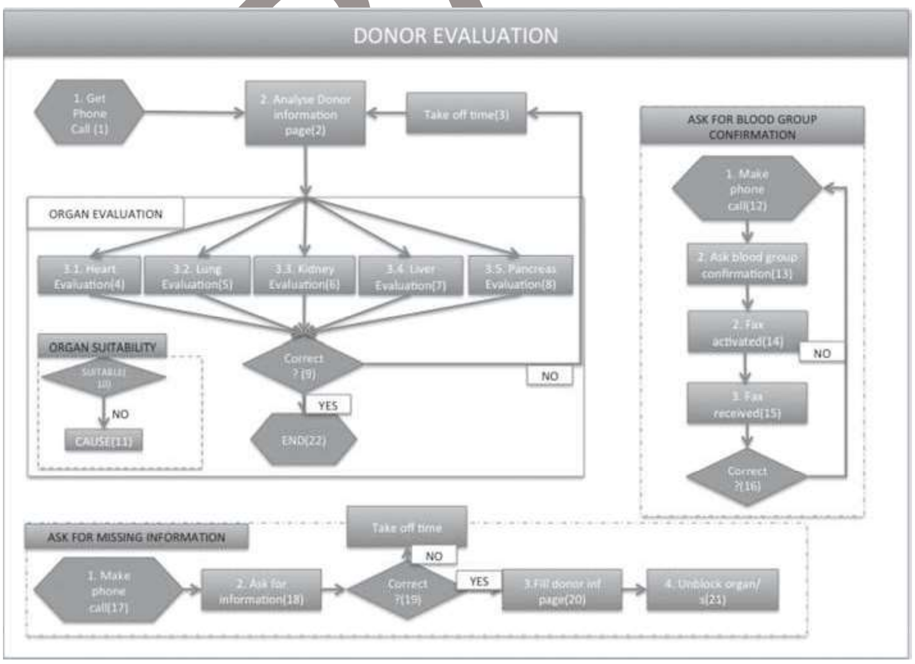

Fig. 4 Storyboard of one of the transplant processes, general overview

values to allow the player to build a way of thinking and problem-solving that is similar to the approach of the field experts (Amory 2006).

The game designer must begin by designing the basic steps that represent the medical procedure (those steps that are usually explicit or easy to elicit). As the design advances, common errors are progressively included as game elements. The goal is to drive students' attention to those aspects that are of the utmost importance (Aldrich 2006). It is also necessary to add traps and to interlace motivational elements to increase the engagement. In this process, the domain experts must also collaborate intensively with the game designers; however, in contrast to the specification process, the initiative here must be led by the game designers, who are responsible for requesting additional information, filtering out aspects that are not compatible with the gameplay and identifying aspects that have not been captured yet.

Instructional design must also be considered in this phase. In this methodology, we place special emphasis on feedback that is provided to both the student and the instructor. We recommend tracking each relevant action (both correct and incorrect) that is taken by the player and use it to generate a report that is either delivered to the student for self-assessment at the end of the game-like simulation or to the instructor for monitoring the students' performance. The report includes detailed feedback about how the student uses the procedure. This information can also be used to identify potential weaknesses in the game-like simulation, correct the formalization of the procedure if necessary and reinforce the learning without requiring teacher intervention.

ONT transplant management game design

Building from the storyboard (shown in Fig. 4, where each of the steps includes multiple actions and decisions that the student must account for while playing), the game designer modeled the different steps and components with game objects. For example, the first step shown in Fig. 4 is answering an incoming call. To implement this step, the game designer used the next game elements: (1) an object to represent the telephone; and (2) the two characters who are involved in the call (the hospital coordinator and the ONT coordinator).

During the game design process, the close interaction between the game designers and the domain experts was a key success factor. The domain experts constantly reviewed for precision checking that the necessary attention was placed on the most risky steps of the procedure. For example, the wrong blood group identification can entail serious damage for the patient, including a high risk of death. Thus, the ONT coordinator must always double check with the hospital coordinator the blood group that is reported onto the donor information page. To emphasize this aspect, one of the donors has a wrong blood group in the information page. If the player does not ask for the blood group confirmation, he will not complete the simulation successfully and will have to start over again to ensure maximum retention.

In contrast, game designers care for engagement and user experience, discarding aspects that could break the engaging atmosphere and proposing the addition of new motivational elements. For example, ONT experts considered that attending random calls from people asking for general information is an important part of their job and therefore the game-like simulation should account for it. However, although this aspect is important for representing the pressure of daily work in the ONT, it is not part of the medical procedure itself. Instead, game designers took a more gamish approach to simulate the pressure of the real job, using the concept of "lives", represented as small heart icons that fade away as time goes on (see Fig. 5 where the player has lost half of one life out of three. The figure also

Fig. 5 Screenshot of the game-like simulation. The figure shows the workplace with several objects to interact with and a live counter

shows the available interactions with the fax). The other game elements that are included are summarized in Table 1.

Game-like simulation development

Starting from the previous output, a game-like simulation is generated. This simulation can be created using a game-authoring tool such as eAdventure (Moreno-ger et al. 2008; Torrente et al. 2010). Game authoring tools reduce the cost and increase the involvement of content experts in the development process. Moreover, using a high-level authoring tool facilitates rapid prototyping, which speeds up content checking processes because the revisions are more productive on working (although incomplete) prototypes rather than on designs or documents. This approach also allows game designers to rapidly test the game mechanics and ideas and to identify major difficulties in the design.

During the first iterations, this task is focused on creating mock-up prototypes (i.e., simulations with provisional art resources), which allows the domain expert to check whether the explicit and tacit knowledge have been properly captured. Intermediate iterations generate prototypes that are oriented toward evaluating the game elements that are included. The final iterations have stable versions, including final art resources to evaluate the engagement with the end users.

ONT transplant management game-like simulation development

Most of the authors of this work are computer scientists and experts in game and simulation development. Therefore, the implementation step was quite straightforward.

We started by developing the complete workflow of the simulation for a single donor case. In this way, we ensured that the common parts of the procedure were correct before developing the specifics of each teaching case. The screenshots used in the game-like simulation, like the incoming phone call at the beginning of the game-like simulation or the action of evaluating the donor organs, are always the same independent of the donor

Table 1 Description of the most relevant game elements included

Type	Game element	Purpose
Object with actions	Fax 	The player receives the fax and learns the importance of verifying the blood group and the serology
	Body 	The player evaluates each of the organs that performs the action "evaluate" on this object
	Telephone 	The player needs to use the telephone to make and receive phone calls
Object	Lives  Clock 	Both of the objects emphasize the importance of time in the process
Hidden information[a]	Serology information 	This element helps the player to better retain that without the serology information the organs cannot be evaluated
	Diabetes information 	This element helps the player to better retain that without the diabetes data, the pancreas cannot be evaluated
	Age of the donor 	This element helps the player to better retain that without the age, the organs cannot be evaluated

Table 1 continued

	Chest X-ray 	This element helps the player to better retain that without it, the lungs cannot be evaluated
Wrong information provided	Wrong blood group 	This game element helps the player learn the importance of paying attention to the blood group
Character	Hospital coordinator 	The player must interact continuously with the hospital coordinator to successfully finish the game-like simulation. The player learns how important the communication is among all of the stakeholders for the success of the process

[a] In each teaching case, the relevant data is missing. The player must make a phone call to obtain the information. Without this information, the player cannot complete the task

chosen. The differences lie in the options that are chosen by the player when answering the phone call or when evaluating each organ. In the following iterations, we gradually included these specifics, such as the hiding of information in each donor information page and the validation of each donor depending on the player's choices.

Nonetheless, some challenges were present. Some were related to the eAdventure tool that was chosen for the implementation of the game-like simulation, which in some cases did not provide the functionality to implement some of the changes demanded by the ONT experts. While these changes were not crucial for the success of the project, we attempted to accommodate them by adding new functionality to the eAdventure tool, because it is free, open-source software.

Quality assurance

The outcome of the quality assurance process is the verification of some or all of the next aspects: (1) *content validity* (i.e., the process has been represented accurately); (2) *reliability* (i.e., the game-like simulation is stable and free of program errors); (3) *usability* (i.e., the game-like simulation is nice and easy to use); (4) *educational value* (i.e., the students can achieve the intended learning goals) and (5) *engagement* (i.e., the game-like simulation is appealing and engaging, accounting for the fact that the game-like simulation must challenge the skills of the player at all times (Chen 2007)).The importance of each aspect varies depending on the specific context.

The validation of the content can only be done by domain experts through a review of the different mock-ups (Kebritchi et al. 2010). A structured approach to the content validation is strongly recommended. Assuming that the target knowledge is organized in the cases, the domain experts can start by evaluating a single teaching case on an early mock-up without considering making errors. If domain experts find any inaccuracy in the game-like simulation representation, then this task would require revising the specification document as well as the storyboard for the next design and implementation iterations. Once inaccuracies have been fixed, domain experts can start reviewing how traps are handled for the selected teaching case. Lastly, the domain experts evaluate the remaining teaching cases by following the same steps, revising each of the specific common errors that are included. Overall, this approach facilitates refining the initial selection of cases performed during the specification process and enables quick replacement of non-representative cases in an early stage of the development.

ONT quality assurance

During the development of the game-like simulation, we opted for a user-centered approach for quality assurance. New versions of the game-like simulation were internally distributed within the ONT to identify any potential flaws regarding the reliability, usability, and engagement. Besides, one expert was especially selected for content review. This evaluation lasted for 4 months and was divided into weekly or biweekly stages.

We have also adopted an approach for post-mortem evaluation of the project (i.e., once the development is complete), which includes pilot testing on real courses of the ONT training program and expert evaluation.

In this pilot testing, 150 students played in groups with the simulation in three different courses. Each group went through a guided execution of the simulation with one donor case, following the instructions of the trainer. Afterward, the students used the simulations freely, this time without guidance and with different donor cases. They played for an hour. After playing, we asked the students to fill out a satisfaction survey. Over 80 % of the students reported the experience to be positive or very positive, stating that it had helped them to improve their knowledge of the processes. This finding suggests that the game-like simulation appears to be reliable, engaging and usable, which are three of the aspects that are evaluated during quality assurance. We could not perform an evaluation of the educational value of the game-like simulation through the experimental research yet because of logistic issues that arose during the courses. However, we plan to do so in the future.

Expert evaluation is being conducted at the present time. Twenty experts have been recruited, and they are reviewing each step of the procedure. We plan to obtain inter-reviewer agreement rates as a heuristic to determine the final efficacy of the methodology in capturing the knowledge.

Discussion

To the best of our knowledge, this study offers a significant contribution in healthcare gaming and simulation for several reasons. First, it provides researchers and developers with a practical development methodology that helps to formalize the knowledge and transform complex procedures into simulations. This overall type of software is not new because it has been extensively explored in the literature. For example, Amory (2006) proposes a very interesting game object model for designing academic adventure games. However, in most of the cases, the authors describe the simulation or game that is developed or reported with respect to the results that are obtained (e.g., the learning gain) rather than the methodology that was followed (Akl et al. 2008, 2013; Moreno-Ger et al. 2010; Roberts and Greene 2011), which is limiting to other researchers by focusing only on reproducing the results that are obtained. Second, there is a lack of analysis on how to integrate game elements in healthcare simulations, because only one document has been found that explicitly discusses how game design principles and techniques can be used to make health games (Brox et al. 2011). Some of the game design elements that were proposed in this study, such as try-and-fail, drag-and-drop to the right position, or choice-making strategies, have been used in our work. We have also contributed to bridging this gap by providing detailed guidelines on how to integrate these game elements into healthcare procedures.

It is not the final aim of this low-cost simulation to substitute the traditional instructional approach of the ONT; instead, we aim to support it and maximize its results without requiring a high investment. The use of the simulation in the ONT training courses has allowed not only the anticipation of the practical part of the course by the students but also the possibility of experimenting in a risk-free environment on the real daily work of the ONT.

Moreover, the development of the game-like simulations also produced a document with a fully formalized procedure, protecting the know-how of the organization and enabling further sharing and reuse. This document has helped us to formalize part of the tacit knowledge that is related to some of the transplant procedures. This formalization has taken place throughout the described methodology, and each iteration has, as a result, not only a better approximation of the simulation to the medical procedure but also its improvement by correcting the errors found in the validation as well as including the tacit knowledge. The teaching cases selected for this simulation were also enriched and systematized thanks to this methodology, because the evaluation process helped to improve some of the cases or to discard other cases that were found to be inadequate.

However, this approach has worked successfully in the ONT case and some other medical procedures (Moreno-Ger et al. 2010; Torrente et al. 2009). There are many medical procedures that require precise hand–eye coordination and for which the manipulation of physical objects (e.g., equipment) is essential. To be able to perform these procedures safely, students must learn the feeling of the real environment. Thus, game-like simulations can help to optimize the instruction by providing students with efficient tools to learn the steps of the procedure before they actually rehearse it on the photo-realistic environment.

Two limitations or drawbacks were found when using the simulation developed for real instruction. The first limitation is related to the behavior that is expected from the nursery staff of the ONT. The staff must be sensitive and understanding as well as always cooperative and diplomatic in the way they address other colleagues and hospital coordinators. Game-like simulations are not the best option for acquiring these elusive soft-skills, because the interactivity with characters is limited; thus, they are still learned with daily practice.

The second limitation affects those experts and students who are not familiar with new technologies. In our experience, there are many of these in the medical field, and these tend to be reticent to change. Extra guidance and support must be provided to these experts. For the students, the problem was that they had several usability problems, having trouble, for example, in understanding the point-and-click actions, drawing out the learning and occasionally not being able to reach an end even with guidance. This issue could be addressed by enhancing the simulation with a built-in tutorial that smoothes the learning curve.

Conclusions and future work

The use of game-like simulations (i.e., screen-based simulations) as a learning tool is a growing tendency in many disciplines (Johnson et al. 2013; Roberts et al. 1992). Those who are willing to maximize the effectiveness of their educational systems move toward this trend once they realize that videogames can be a powerful tool, rather than seeing them as “mere entertainment”.

In this article, we provide a detailed description of the methodology that is followed to design and develop a game-like simulation from a traditional case-based teaching method. In this work, we have explored how the development of game-like simulations can be used to capture and formalize the highly specialized knowledge that many organizations have. We have developed a methodology that facilitates interaction between domain experts and game designers and the rapid development of prototypes, which in turn facilitates a rapid revision of the formalized knowledge. We have applied the methodology in the ONT, a world-leading organization in the field of organ deceased donations.

Currently, we believe that we have achieved our goal of successfully transforming case-based teaching into a game-like simulation approach based on two facts: (1) The preliminary results obtained from the expert evaluation being performed at this moment suggest that the knowledge has been correctly captured. (2) Because the ONT itself has included this material as part of its instructional approach, we can assume that the simulation properly represents the procedure.

By developing this simulation, the ONT has enhanced its training strategy with the ONT simulation. We believe, based on the feedback reported by ONT experts and on the student’s opinions, that students understand better the ONT procedure as they “get into context” from the moment that they start playing. One of our future objectives is to organize an experiment in a controlled environment in which we will be able to analyze and study whether there are learning gains and compare students’ scores in the course with and without the simulation.

Additionally, this game-like simulation supports effective decision-making. The student must analyze the available information, decide the best action and execute it in the game-like simulation. This game-like simulation guides the student in discovering all of the available information that is needed to make decisions and advance in the execution of the procedure.

Other future plans in the project include the development of other game-like simulations to cover the complete ONT supra-hospital processes training course. This arrangement means representing all of the steps of the process of organ deceased donation, including organ allocation to hospitals and the transport and logistics that are involved. Additionally, we aim to analyze how all of these simulations can be effectively distributed to final users [e.g., integrating the simulations into an e-learning environment such as Moodle or LAMS (Blanco et al. 2010)].

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