Towards a knowledge-intensive serious game for training emergency medical services

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ABSTRACT

In the preparedness activity for disasters and emergency management, serious games can help in training medical first responders by providing emergency simulations which are always available, safer and cheaper than real-world simulations. However, serious games for training emergency medical services (EMS) must take into account the presence of different actors in crisis situation like police and firefighters and the high volume of (medical as well as non-medical) expert knowledge. The aim of our approach is not only to acquire technical skills but also to develop the capability to act, to cooperate and coordinate in non-procedurally previewed emergency situations. This paper proposes both (i) a detailed prototype of a serious game's scenario that supports instructors in the training in EMS and (ii) an adaptive infrastructure A.R.G.I.L.E (Architecture for Representations, Games, Interactions, and Learning among Experts). We illustrate our ideas on an example of a complex road accident. This work is done with the collaboration of a Hospital Emergency Department implied with us in a R&D project.

Keywords

Serious games, e-training, crisis situations, discussion forum, participatory design.

INTRODUCTION

Today, the term serious game is becoming more and more popular. According to (Corti et al., 2006) game-based learning/serious games "is all about leveraging the power of computer games to captivate and engage end-users for a specific purpose, such as to develop new knowledge and skills". Serious games are present in many areas of knowledge, including defense, manufacturing, education and medicine, among others. We propose the characterization of serious games by using the following main components: rules and gameplay, challenges, interaction modes and goals. (Prensky, 2002) defines gameplay not only as the game experience and/or the game activity, but also as the group of strategies used by game designers for engaging players and keeping them motivated. Other researchers affiliated to a ludological position, such as Jesper Juul (Juul, 2005), choose to emphasize the connection between gameplay and rules that may create the gaming experience: I believe that gameplay is not a mirror of the rules of a game, but a consequence of the game rules and the dispositions of the game players.

Decision making in highly dynamic, complex situations is difficult. The literature on complex problem solving and natural decision making provides interesting insights into human error tendencies and has pointed to numerous traps and pitfalls we are likely to stumble into (Strohschneider et al., 1999). If we translate "complex problem solving" into "management of crises and emergencies" (Danielsson et al., 1997), it has become quite obvious that training and education are mandatory. After all, emergencies and crises are among those situations where deficient problem solving is dangerous and can become extremely costly on different dimensions. The widespread adoption of computer games for entertainment purposes, the continuous decrease of hardware cost and the success in military simulations made gaming technologies attractive to some "serious" industries such as medicine, architecture, education, city planning, and government applications. The emergency management is based on "staff work" that focuses on planning, coordinating, and monitoring operative procedures (Orasanu et al., 1996). Communication and coordination is very important between emergency management teams

(Schaafstal et al., 2001). Our goal is an attempt to co-develop a learning environment that equips persons working in emergency medical services with the knowledge and skills necessary to act as members of such a staff and deal with rare crises and emergencies.

The rest of this paper is organized as follows. From some readings, the section II defines a characterising crisis management. The section III proposes a preliminary overview on the use of serious game in emergency health care. The section IV details our scientific positioning and defines our approach of serious games "participative and intensive in knowledge", with an example of existing MMORPG forum and several mock-ups intended to illustrate the key concepts. The section V summarizes the conclusions of this paper and presents its perspectives.

CHARACTERISING CRISIS MANAGEMENT

Crisis management is complex and we do not aim at its complete characterization, but rather outline general issues for designing serious games useful for preparedness. Let's use a simplified example to help us in this task. The worked example is real; it's the result of interviews we conducted with trainers at the mobile Emergency Medical Service (EMS) in the (middle town -150 00 inhabitants) hospital participating in our project. During a winter Sunday, a tank truck transporting potentially toxic material has an accident with a van (see figure 1) on a national highway 25km from the EMS basis. If this toxic material gets in contact with air, it causes a major air contamination. The situation requires the coordinated intervention of multiple units: firefighters trying to avoid contamination; medical units taking cares of victims and police trying to avoid traffic problems. So, we are dealing with a complex problem, and we have different solutions with associated costs and risks.

Figure 1. Crash between a tank truck and a van (image proposed to the learner in the serious game)

The interference between predictable and unpredictable events, the impossibility to only apply predefined procedures, characterizes such a crisis. In our example, accidents involving vehicles transporting toxic material are a well-known problem for which protocols of action are defined. However, nobody can predict when/where this will happen and the context, like type of transported material, weather conditions, victims' number or population in the area. Toxic risk can happen in combination with other factors (meteorology, organizational problems…). During a crisis, the main problem is divided into many sub-problems, e.g. securing the area, taking care of the victims, putting population in safe conditions, avoiding contamination, contacting the main hospital to accommodate victims and so on. Once the main problem is divided into sub-problems, action has to be planned. Each unit might define plans for sub-problem they have to handle, but with the need to coordinate the effort. Plans have to conform to approved protocols of action. Action leading to an optimal result locally is not always leading to the intended global result. For example, "*divert the traffic in one direction might reduce congestion in one area, but create problems to emergency vehicles parked in another road"* says a doctor at the EMS of the hospital. Members in a crisis management team need to communicate to coordinate their action. For example, if firefighters are the first to be present in the area, when emergency doctor arrives, he must contact directly the commander of rescue operation (COS[1]) to know more about the accident. Also, the time is very important for decision making in our example: the tank truck can start spilling out toxic material and contaminate the air if the emergency team is not able to act quickly; or an injured situation may become worse if he don't receive first aid quickly. Crises are related to specific social and physical contexts that influence their

[1] the head of department of body Firemen (COS: Commandant des Opérations de Secours)

management. If our example is happening in a highly populated area with schools or university nearby, we are submitted to different requirements than if the accident happens in an isolated area. As we can see crisis management is a task that can rise in complexity very quickly. Emergencies are made up of both predictable and unpredictable elements. Crisis management works exactly anticipating the former in order to minimize the damage (Palen, 2007). One of the ways to anticipate unpredictable events is building predictive models or scenarios and uses them for training. Managing unexpected elements requires instead to learn not only how to behave during the crisis, but also the importance of passing the right information, in the right amount, at the right time, from the right place, to the right person (Sagun, 2008).

A PARTICIPATIVE ARCHITECTURE ADRESSING CRISIS MANAGEMENT E-TRAINING CONSTRAINTS

In this section, we justify and present our detailed approaches of the co-design system and the learner's forum before explaining our technical infrastructure.

Co-designing the Serious game elements with the A.R.G.I.L.E system : Why and how ?

First we propose in the A.R.G.I.L.E system (Architecture for Representations, Games, Interactions, and Learning among Experts) a participative approach to associate EMS experts into an efficient writing of crisis scenes scenario. Developing Serious Game sequences for numerous cases (including cases at a very low probability) is necessary, but very expansive with traditional game editors. It is easy with traditional methods to formalize well established prescribed procedures, but a characteristic of a crisis is precisely that prescribed procedures often are not sufficient, and have to be completed by experience. To involve experienced EMS people in the scenario design is a good means to capitalize Knowledge and transmit it to novices. Actions that are almost easy for experimented emergency doctors might be extremely challenging for newcomers, both technically and in terms of emotional response (especially if the crisis is rarely to happen). That's why experts have to be active in the co-design process we propose.

Our challenge[2] is to transfer the accumulated knowledge flowing from concrete experiences, well-documented and discussed by trainers in EMS (in other words, reliable data), to a training model in which actors will be actively engaged. These knowledge are neither stabilized nor unanimous, but on the contrary dynamics and in continuous evolution. The actor does not always make his decisions according to pre-established recipes. He mobilizes all his intelligence, to proceed by trial and error, to communicate with his peers and to discover continuously the suitable solutions in complex situations proposed to him. The innovation in our approach is the co-conception of rules and certain objects of the game by the trainers of the domain. We make the hypothesis, that rules, knowledge and objects of the game can be written, commented, discussed easily and modified by trainers in EMS, with the help of the researchers (cf. Figure 2 – left), but without to delegate the design to IT specialists and specialized software editors. We also wont to verify the hypothesis of a better quality of the knowledge for crisis management "on the field", if co-designed by this way. The proposed architecture offers to the designers a Web-based working system which articulates:

- A specification system directed to teamwork susceptible to associate skills of experimented emergency doctors and nurses

- A navigation system in the game objects (this point is particularly crucial in the applications of knowledge-intensive in game, which contain numerous objects and rules),

- A discussion forum type: crisis management games rules depend on places, seasons, physical and social context and many other factors. That is why for a designer who builds objects and rules of a scene, it is important to have a design forum for the discussion between peers.

All designers (UTT[3] researchers and trainers in EMS) are invited to join the "design forum" to discuss new rules before implementing them in the game. Figure 2 (right) presents the design forum for an object ("Overturned truck"), it shows the rule discussion corresponding to this item, whose name appears in the URL (each object has a specific URL).

The initial designer suggests for this item:

[2] A subsequent challenge could be making designing the game… a game. Presently we only put the emphasis on the discussion /vote features of the forum, but "gamification" of the design (with additional shields, rewards…) such as in the "stack overflow" developpers fora, could be an interesting issue to explore. Eliciting expert knowledge is often a hard task, easier to be done with such "extra" motivation.

[3] UTT: Université de Technologie de Troyes

- On knowledge level: search if the track has a danger sign like "flammable liquids stored here".

- On pedagogical rule level: if a player didn't think of danger signs, a message will appear to alert him about it.

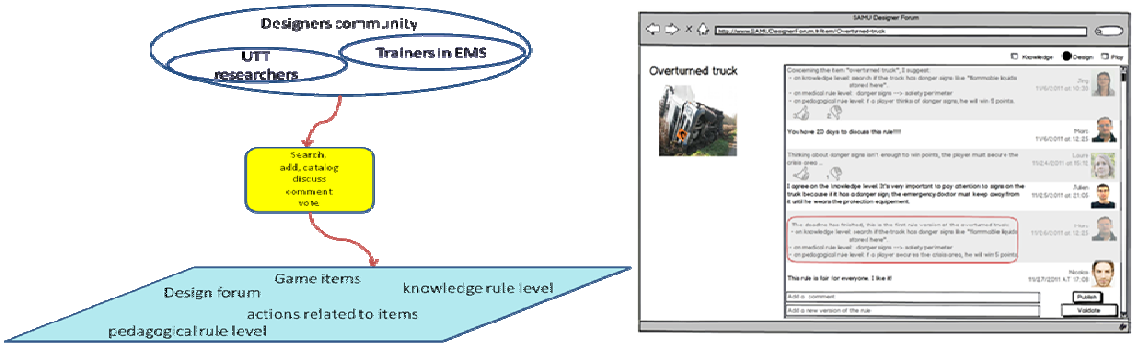

Figure 2. Participative architecture and discussion forum

Another designer comments that thinking about danger sign isn't enough; player must pay attention to it within 8 minutes due to its priority. Every object or action has a discussion thread on the forum. Every time that a designer implements the first version of the rule, a discussion thread is opened in the forum, and actors are notified. The rule appears as a message in the discussion thread, so it's easy to modify it. Hospital emergency trainers involved in the project don't prefer that the won/lost points system appears to learners in the game. "*The won/lost points system is important for us, as trainers, at the debriefing phase. We prefer that it will be hidden to learners because it will influence on them*" says a doctor at the hospital EMS. We are in the context of interactive pedagogy, so trainer watches players where they are playing and can add in real time new items or messages or sounds to complex the situation and to teach specific knowledge.

Detailed approach of the learners forum

A When the rule "is released ", the discussion which it caused is available in the game scene: we suggest to the player-learner the he can investigate rules attached to scene objects the learner is encouraged to mobilize the rule and it discussion thread as resource "to play better".. The means for that is a "learner's forum", combined with the precedent "design forum". In that matter lessons can be learned from MMORPGs (Massively Multiplayer Online Role-Playing Game Play). The MMORPGs are a type of video game that allows many players to simultaneously interact in a virtual persistent world. Players' discussion forums are increasingly used by the MMORPGs Players' Communities. Figure 3 shows a part of the "Wowhead forum", created by World of Warcraft (WOW) players. This page is dedicated to the "Thorium[4]" topic. The complete page contains hundreds of knowledge elements like comments, discussions; screenshots ...This example is similar to what we want to do with "participative rule".

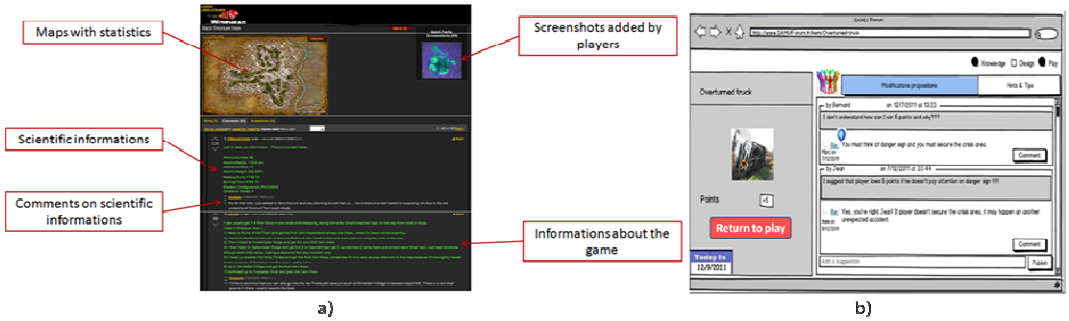

Figure 3. a) The WOWHEAD-Forum page dedicated to the "thorium"; b) the A.R.G.I.L.E learners forum

WOW is neither a "serious game" nor a "useful games". Knowledge on "Thorium"" does not represent any scientific Knowledge, but players' behavior is as serious as in a Serious Game! (What defines the player and the playful character is that he is inside the game and takes seriously its purposes, whatever is this game). In this example, like in Wikipedia, crucial knowledge to operate the game is cooperatively constructed by the player's Community. Players complete for example the geographical map with statistics about the regions concerned by

[4] Thorium is originally a radioactive chemical element, but in the WOW game it undercomes with an additional coherent set of fictional properties, as a resource useful to win; for more details, see: http://www.wowhead.com/object=175404

a given crucial resource (here, the “Thorium”). Note that WOW is a commercial product (Blizzard), but the Wowhead forum is organized by the Players community to exchange Knowledge independently from the WOW society, and sometimes in conflict with official WOW knowledge (e.g. WOW do not diffuse statistics on “Thorium” localization). When the rule "is released ", the discussion which it caused is available in the game scene: we suggest to the player-learner that he can investigate rules attached to scene objects. The learner is encouraged to mobilize the rule and his discussion thread as resource “to play better”. Around the rule, the players are invited to exchange between them; "hints and tips". Complementary to the use of statistics, these "narratives" give designers more qualitative and richer returns. Finally, players can suggest improvement ideas for the game, introducing them, little by little, into the universe of designers and experts. To encourage learners to contribute and to improve the game, they have to feel that their proposals are examined and lead to improvements in the game.

A designer appreciating a player proposal for changing a rule cannot alone modify this rule, because changing a rule depends on the discussion between the designers groups participating to the design forum of this rule. That is why, regularly, the group of designers should discuss new players’ proposals to decide if they reject, adopt or postpone the proposed modification of the rule. In our approach, learners won’t only learn from practicing in the game itself but also from the discussion of rules games via the forum and from the knowledge exchanged between them.

CONCLUSION AND PERSPECTIVES

In this paper, we proposed for Crisis Management (in the preparedness stage) a new approach of participative and knowledge-intensive serious games. We proposed, with the A.R.G.I.L.E architecture functional and technical solution elements, by indicating on some examples why this solution is the most suitable to these games service. This reflection comes along with a work plan for the architecture implementation which allows us to validate gradually certain underlying hypotheses in our proposal. The current stages include in particular the setting-up of the mock-ups of forum solutions presented in the present paper, and of the graphical editor. We wish as soon as possible realize more advanced experiments to validate our hypotheses.

Our first objective is to evaluate the ability of learners to improve the game based on suggestions to the forum, and to evaluate increased learning among learners because they learn not only from the serious games (which the main aim of serious games) but only from the discussion through forum.

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