

The Design of Generic Serious Game Shell

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Abstract - In order to facilitate the use of online serious games in schools, a team from the Centre for expertise and research in lifelong learning (SAVIE), under the supervision of professor and researcher Louise Sauvé, focused on developing and experimenting on the Generic Serious Game Shell (GSGS). This is done in order to equip teachers with the ability to easily develop online educational games which are adapted to their pedagogical needs. This paper presents the process and guidelines (pedagogical and technical) that guided the development of GSGS as well as an example of a serious game – Escouade H2O.

Index Terms - Serious games, educational games, learning design models, e-learning, generic shell.

I. INTRODUCTION

Currently, millions of students invest a phenomenal amount of time using computers, the internet and playing games. The success of video games now rivals television and the film industry since it has become the most desirable form of entertainment (Hutchison^[1]). Today, it is possible to play games on consoles, personal computers and also the Web. Some of these games are qualified as ‘serious’ because of their pedagogical objectives. Serious games, the confluence of e-learning and videogames, have been developing very quickly these past years. These games combine aspects of tutoring, teaching, training, communication and information, with entertainment elements derived from videogames, in order to capture people’s attention for purposes that go beyond pure entertainment (Tran, George & Marfisi-Schottman^[2]).

Several meta-analyses of research studies and results have described the effectiveness of the games for cognitive, affective and psychomotor learning. According to these studies, the game motivates the learner, offers immediate feedback, increases the learner’s active participation, reinforces knowledge, contributes to the development and application of acquired skills and the transfer of learning and finally, influences behaviour and attitude changes (Baek^[3]; Sauvé^[4]).

The creation of a serious game for educational purposes is a very time-consuming and expensive process. The challenge of the research development is to develop and experiment with a user-friendly Generic Serious Game Shell (GSGS) without the need for data-processing knowledge. A GSGS is an online design environment that facilitates serious game creation by teachers and trainers, providing them with the tools they need to: (1) set technical and pedagogical parameters for the game; (2) create strategies and rules that direct players’ actions; (3) create

learning materials; (4) set criteria to define the end of the game and determine the winner; and (5) expand on the tools required for game review and evaluation, ensuring that the game is regularly updated and strengthening its learning efficiency. The development process for an online GSGS generally include five stages: Preliminary analysis, Design, Media Development, Validation of the GSGS (trial) and Evaluation of learning.

In the context of this paper, we will first present the guidelines (pedagogical and technological) that directed its development. Second, we will demonstrate an example of a serious game that was created using the GSGS to develop autonomy and an understanding of cause and effect relationships in high school students to encourage them to be responsible consumers of water: Escouade H2O.

II. THE CONCEPT OF GENERIC SERIOUS GAME SHELL

The concept of a Generic Serious Game Shell (GSGS) is based on the frame game concept which was elaborated by Stolovitch and Thiagarajan^[5]. A frame game is an already existing game, such as Snakes and Ladders, from which the contents are removed leaving only its basic structure. Any game can be broken down into two main parts:

- The game’s *structure* determines the way the serious game is played: rules, the stages of the game and player moves, challenges that the players face, and strategies which they can use to win. In the context of a serious game, we say that we “empty” the serious game of its content to uncover its unique underlying structure. This structure, once clearly defined and analysed, becomes a “frame,” or a “generic game shell,” when it is programmed and put online.

- The game’s *content* consists of the information employed in the serious game: this content is generally found (for non-computerized games) in cards and on game boards. In the case of serious games, it also includes stated learning goals and competencies to be developed by playing the serious game. Once a frame game is fully defined, it is enough to insert new content, accompanied by predetermined learning objectives, to generate an up-to-date educational game adapted to a particular target group.

It is the structure which will form, in the serious game conception environment, the necessary components for its programming. The frame game would be a good example of this but what renders it particularly useful is that the contents can be changed while remaining perfectly compatible with the structure. It is this fundamental characteristic, the fluidity of the content, which makes the frame game an interesting pedagogical tool.

Once the structure of the game has been updated and programmed through the generic serious game shell (GSGS), it can also generally serve a wide array of different pedagogical needs. Based on the same GSGS, it is possible to generate new serious games as well as new content that is compatible with different clientele, objectives, teaching goals and languages of use.

III. THE PROCESS FOR DEVELOPING DESIGN ENVIRONMENTS FOR SERIOUS GAMES

A serious game is a computer application, the initial intention of which is to coherently combine serious aspects including, but not limited to, education, learning, communication, and information, with the entertainment value of video games. In the context of our study, serious games are an environment that can be fictional and realist in which players operate in a state of conflict or cooperation, guided by rules, they strive to attain a predetermined game (to win, succeed, or exact revenge) and to meet specific learning objectives.

The development process for an online GSGS was adapted by Sauv  ^[6] from learning design models (McGriff^[7]; Tang, Hanneghan & El-Rhalibi^[8]; Price & Moore^[9]; Marfisi-Schottman, George & Tarpin-Bernard^[10]) that generally include five stages:

- **Preliminary analysis and planning:** analysis of the target learner group(s) and the learning context; specification of the shell's pedagogical and technological requirements; review of existing frame games; and selection of the structure of the game to be adapted.
- **Design:** description of the structural components and content elements of the existing game to be saved, modified, or added to create the shell; creation of a design model in the form of screen pages and reference documents describing the GEGS components.
- **Media development:** development of technical specifications for the online shell's graphic and multimedia components; programming of different elements and their functions in the shell; and functional integration testing of the shell.
- **Validation:** specification of the formative evaluation framework; development of evaluation instruments for the target population; target population trials; and making any necessary revisions.
- **Evaluation of learning with the serious game created with the GSGS:** development of a serious game using the shell; specification of the experimental framework; development of measurement instruments to be used by experts and the target population; validation of the game by experts, and revisions if necessary; game trial by the target population, and revision of the game and the shell if necessary.

IV. THE GUIDELINES (PEDAGOGICAL AND TECHNOLOGICAL) FOR THE DEVELOPMENT OF GSGS

The expectations of an online serious game (Sauv  , Renaud and Gauvin^[11]) in the academic context are namely that it:

- be reliable, convenient and complete;
- be flexible so that it can be easily used in different learning situations. This means, among other things, that teachers can adapt the game to their students' needs and class schedules;
- be straightforward (*ready to go*), and easy to use so that teachers can easily find all the necessary elements for a given context or situation;
- allow changes to game content at any time to ensure that it is accurate and directly linked to the teaching programs;
- support activities that support attaining cognitive and affective objectives from simple to complex;
- integrate different types of learning activities through closed or open-ended questions with varying degrees of difficulty;
- provide activities which allow a player to complete a learning goal (with the help of an information module) before responding to a question (e.g. demonstrations, situational role-plays);
- produce games that can adapt to a class's technological context by being playable on one computer or on multiple computers according to available equipment;
- allow the insertion of video scenarios for work on behaviour or to support other types of learning;
- allow the formulation of text, visual, audio or audiovisual based questions;
- allow the formulation of different types of answers, including intermediary choices (neither yes or no, grey zones);
- allow text, audio, or audiovisual feedback;
- allow prompt, just-in-time feedback linked to learning;
- insert motivational feedback as text, audio, or icons;
- support reflection on the material learned (metacognition) following the game, with the help of a debriefing questionnaire;
- save each player's results in a personal folder, viewable by the player;
- allow each player to measure her learning during the game and at the end of the game, with real time feedback;
- allow the teacher to provide complementary pedagogical material or to suggest activities once the players have completed the game;
- offer mechanisms that facilitate adaptation of a game into another language (French or English).

Finally, the game had to be well-known and very popular among the target audience, to reduce the time it takes to learn game rules and how the game board works.

The structure of the GSGS must be sufficiently adaptable so that it can:

- allow players to cooperate by forming groups or teams to work together to win the game;
- create competition among players and provide them with a challenge that would maintain their interest and involvement during their in-game learning;
- include a point system as a formal indicator of success or failure in learning the material;
- offer different paths on the game board to increase the uncertainty of a player's chances of winning;
- support real-time exchange (audio and video) between players;
- play solo against oneself (by creating a fictitious opponent), in teams (with collaboration mechanisms), and against other players or in teams (using conflict mechanisms).

V. THE ADAPTATION OF THE FRAME GAME TO THE GSGS

In order to meet the parameters of a serious game while taking into account the essential attributes of an online serious game and keeping in mind learning objects, our choice of video game type was a Treasure Hunt. The basic scenario is always the same: the player or players must solve a series of mysteries (through questions or activities) in order to find the treasure and to win the game. The player faces obstacles from adversaries and rival teams or the game scenario. A treasure hunt can be done in teams (of 2 to 6 players) as long as the game is online or it is played in a real-time situation.

To create the GSGS, we adapted the structure of the game and the rules in the following way:

- the path to the treasure is comprised of a trail of 9 blocks on a dynamic board game;
- the number of players or teams is variable: 1 to 4 players. A solo player will play against one opponent or the computer. Two players or two teams of two players can also face each other;
- the treasure is an improved environment: nine improvements must be found in order to win the treasure or the round;
- obstacles come from the opposing team or Action cards;
- the mysteries to be solved are presented as questions or learning activities to be completed. These activities allow players to develop knowledge, simple or complex, and to modify behaviours or attitudes: True or False, Yes or No questions, Multiple choice questions (2, 3 or 4 choices), Fill in the blank questions (2,3 parts), Logical ordering questions, Short-answer open-ended questions, Role-playing questions, and *model* type questions. All these

activities include a correction and feedback mechanisms in real-time;

- the minimum number of questions or learning activities correspond to the ten turns that the players must complete in order to win the improvements. If the nine improvements are not won in the ten turns provided, additional turns will be granted to the players until they can obtain the improvements required to win;
- the addition of Action cards can either help the player or worsen his/her adversary's situation;
- multiple rounds can be played in order to improve the average score or placement of a team. Each round offers an environment that can be improved and different questions in order to maintain the degree of difficulty and challenge.

Once the concept for the GSGS was determined, we developed forms for creating a game as illustrated in Figure 1.

Fig. 1. Example of a form for creating a game

VI. CREATION OF A GAME USING THE GSGS: ESCOUADE H2O

Based on the GSGS, we put together a first serious game, Escouade H2O. It is designed to teach grade 10 and 11 students to adopt responsible habits for using water (Sauvé, Sénécal, Leclerc, Bilodeau and Bertrand^[12]). The goal of the game: be the first player to attain the nine improvements in the environment to win the round. If the environment is not complete after ten turns in the first round, the players take extra turns until one of the players has completed his/her environment. Figure 1 demonstrates the interface of the game:

- A game board with 6 steps on a determined path. Each step allows the player to acquire resources (ex. water or flowers) or to lose resources (ex. garbage bag). On each side of the game board is a lateral panel with information (one for each player or team). Each panel displays the following information: the points, the beneficial resources acquired (ex. drop of water, flower), the detrimental resources (ex. garbage bag), the pawns, the image of the

evolution of the player's environment, the three levels of improvements, the name and avatar of the player, the audio level of the player's microphone, etc. The lateral panel in figure 2, for this description, displays two different environments for player 1 and player 2. For player 1, we can see the initial state of the environment - a polluted waterway to which the player must add 9 improvements during the obstacle course throughout the game. For player 2, we see the environment after the 9 improvements have been achieved.



Fig. 2. Board game and information panel

- A six-sided dice determines who will begin the game and a ten-sided die (on which there are the ten pawns) determines which pawn will be assigned to each player during additional turns.
- Two sets of 10 pawns: 6 strength 1 pawns, 3 strength 2 pawns and 1 strength 3 pawn.
- Three resource series: Resource 1 : drop of water (4 steps provide 1 drop of water, 1 step provides 2 drops of water); Resource 2: flower, more rare (1 step provides 1 flower and 1 drop of water); Resource 3: garbage bag (acquired when a wrong answer is provided).
- Three levels of improvement costs: Level 1 has a value of 2 resources 1 (drop of water); Level 2 has a value of 4 resources 1(drop of water); Level 3 has a value of 5 resources 1 (drop of water) plus 1 resource 2 (flower).
- A series of questions: Over a hundred questions and activities were created to cover the material the game will be teaching (Figure 2). These questions are displayed randomly and are regrouped in three levels according to difficulty (easy, medium, difficult).
- A series of Action cards. The cards are displayed at random in three instances during the game, during turns 3, 6 and 9. These are obtained after giving a correct answer to special questions that players are asked. Some cards improve the player's situation and others are detrimental to the player's adversary. Here are a few examples of Action cards: (1) Win a strength 2 pawn. This pawn can be placed immediately, it must be kept guarded in a bank and placed during the next turn. (2) Win and immediately place a strength level 2 pawn. (3) Win 4 drops of water.

- (4) Remove a strength level 1 pawn that belongs to your opponent from the game board.
- (5) Win a rare resource. (Flower).
- (6) This card blocks all resource collection from this step for the rest of the game.
- (7) This card allows the collection of 1 drop of water from this resources step.
- (8) Steal a level of improvement from your opponent.

The twelve rules of the game guide the players and determine how the game will end. Refer to figure 2 and the following address to see the rules: http://www.savie.qc.ca/CVJE_travail/Site/Jeux/MSG Eau/ReglementsAn.asp?NoPartie=1174

The content of the game is divided into four complementary themes that allow the players to discover a global perspective of water thanks to the entertainment value, namely: (1) Water, biology and science: the importance of water in the biological human process, the diseases transmitted by non-drinkable water, the physical properties of water. (2) Water, territory and management: Water in Quebec- lakes, rivers, streams – the sources and uses of water in society (industry, agriculture, energy), the pollutants and the treatment of water used. (3) Consumption and preservation of water: direct consumption of water in Quebec, indirect consumption of water through consumption of goods and food, the problems with consumption: for example, bottled water, alternatives and pathways to solutions. (4) Water in the world: different realities concerning access to water as a resource in different parts of the world, examples of world problems, examples of good management.

VII. CONCLUSION

With the coming of the information highway and the diversification of learning technologies, interest is growing more and more for the use of serious games in the learning environment, whether initially or continuously. According to Livingstone^[13] and Ridley^[14], games have become the principal form of entertainment for learners when compared to books or other types of media.

All teachers who hope to create ideal opportunities for students to learn, should choose the most appropriate pedagogical methods for the learning situation. Despite the advantages of serious games, few teachers and trainers use this method due to the lack of appropriate materials for their training or teaching situation. It is within this context that the GSGS on the Internet- Treasure Hunt- was developed. These environments give the opportunity to teachers, trainers, pedagogical councillors and education specialists to rapidly develop serious games in light of specific learning objectives. The serious games that have been developed are available freely to all teachers and students anywhere in the world, in many languages (French, English, Spanish). To learn more about the steps of developing a GSGS, refer to Kaufman and Sauvé^[15].

Grade 10 and 11 students registered in a Web tournament (<http://eau.savie.ca>) will try out the Escouade H2O game in the fall of 2011. During this tournament, the

teams will play 8 games and the difficulty level will increase accordingly. The team with the highest score will win a prize. The game is offered in French and in English.

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