A Generic Serious Games Shell for Diversifying Distance-Learning Methods

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Abstract - In order to equip teachers to develop serious games, a research team designed a Generic Serious Games Shell (GSGS). This environment facilitates the creation of serious games adapted to distance learning without the need for data-processing knowledge. In this paper, we will present the concept of GSGS. Then, we will summarize the process for this creation of GSGS: (1) Preliminary analysis, (2) Design; (3) Media Development, (4) Validation of the GSGS (trial) and (5) Evaluation of learning with a serious game created with the help of the GSGS. We will discuss the guidelines (pedagogical and technological) that directed its development. Finally, we will describe an example of a serious game that was created using the GSGS: *Escouade H2O*.

Keywords : Generic shell, Serious games, distance education.

INTRODUCTION

Currently, millions of students invest a phenomenal amount of time using computers, the internet and playing games. These young people, strong on techno, are hooked on games of skill. The success of video games now rivals television and the film industry since it has become the most desirable form of entertainment (Hutchison, 2007). Who are these students to whom we teach?

Online games offer to the digital generation (Digital Natives) the opportunity to make use of inductive reasoning, to increase their visual abilities and their capacity for cross-checking information sources (Van Eck, 2006). The game allows the player to resolve cognitive conflicts. “Playing a game demands a constant cycle of hypotheses, tests and revisions”.

“The game generation” has developed a new cognitive style characterized by multitasked learning, a relatively short attention span during the learning process, and a way of learning which relies on exploration and discovery (Prensky. 2006). Today’s teenagers are “born” communicators, intuitive and visual (Oblinger and Oblinger, 2005). They have strong spatial and visual aptitudes which are due most assuredly to their practice of video games. They prefer to learn through experimentation rather than following a teacher; they pass easily from one subject matter to another and also from one activity to the next when the activity does not offer great interest. They respond with promptness and demand a rapid answer in return. The use of video games has modified the way young people learn from a constructivist approach: the student first plays, then comprehends and finally generalizes to apply what has been learned to new situations (Shaffer, Squire, Halverson & Gee, 2004). The young internet user wishes the following during the learning process: interactivity, interaction, active visualization, and immediacy.

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, 2010; Sauvé, 2010a). 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, 2010).

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 Games 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.

In this paper, we will present the concept of GSGS and the process for this creation. We will discuss the guidelines (pedagogical and technological) that directed its development. We will describe 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 (in french).

THE CONCEPT OF GENERIC SERIOUS GAMES SHELL

The concept of a Generic Serious Games Shell (GSGS) is based on the frame game concept which was elaborated by Stolovitch & Thiagarajan (1980). 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 games 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 games 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.

THE PROCESS FOR DEVELOPING GSGS 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 Sauvé (2006) from learning design models (McGriff, 2000; Tang, Hanneghan & El-Rhalibi, 2007; Price & Moore, 2010; Marfisi-Schottman, George & Tarpin-Bernard, 2010) 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.

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

The expectations of an online educational game (Sauvé, Renaud & Gauvin,2010) 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).

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

THE 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, 2011). 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 twelve turns in the first round, the players take extra turns until one of the players has completed his/her environment. Figure 2 demonstrates the interface of the game:

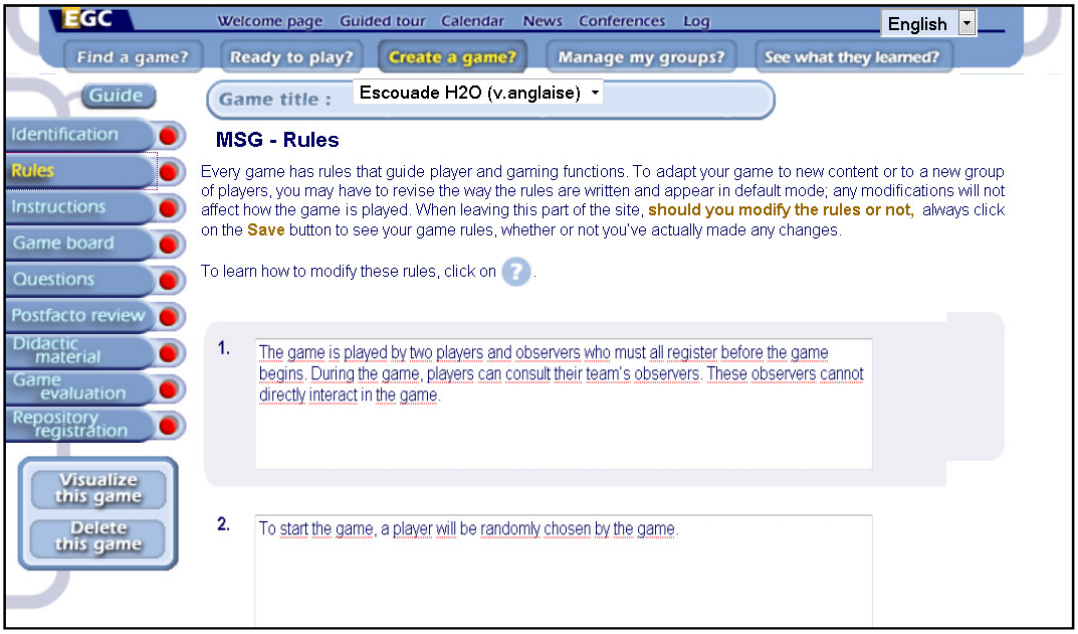

Fig. 1. Example of a form for creating a serious game

- A game board with 7 steps on a determined path. Each step allows the player to acquire resources (ex. water or flowers) or to lose resources (ex. radioactive waste). 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. radioactive waste), 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.
- 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 step provides 1 flower and 1 drop of water); Resource 3: radioactive waste (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 3). These questions are displayed randomly and are regrouped in three levels according to difficulty (easy, medium, difficult).

Fig. 2. Board game and information panel

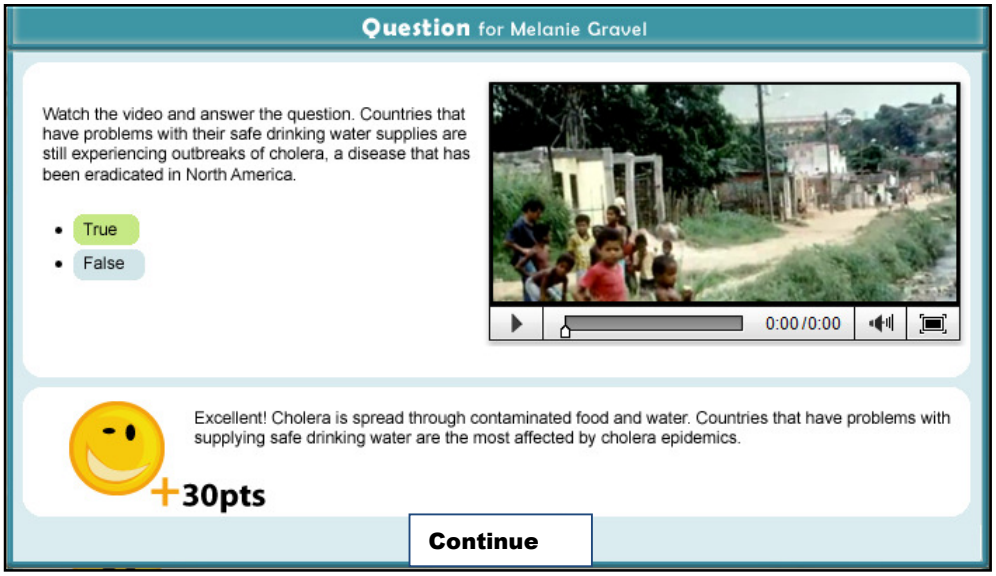

Fig. 3. An example of question

- A series of Action cards. The cards are displayed at random in four instances during the game, during turns 3, 6, 9 and 12. 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 and immediately place a strength level 2 pawn. (2) Win 4 drops of water. (3) Remove a strength level 1 pawn that belongs to your opponent from the game board. (4) This card blocks all resource collection from this step for the rest of the game. (5) Steal a level of improvement from your opponent.

- The ten rules of the game guide the players and determine how the game will end (Table 1).

Table 1. Rules games

1. The game is played by two players and observers who must all register before the game begins. During the game, players can consult their team's observers. These observers cannot directly interact in the game.
2. To start the game, a player will be randomly chosen by the game.
3. At the beginning of the game, the game engine places the pawns on the starting step (Player's entrance). Each pawn can only be placed one time. The players use 1 pawn everywhere.
4. Once the players have begun the game, turns take place in the following manner:
   a. In every game turn, the player places a pawn on a square that he/she can access on the pathway. To be able to access a square, it must be linked in the pathway to a square already controlled by the player.
   b. The pawn cannot jump over an unoccupied square or go around a square that is controlled by the opponent. The player can place multiple pawns on a square he/she already controls or on a square that the opponent controls, placing one pawn per turn.
   c. Once the pawn has been placed the player must answer a question. A correct answer is worth 30 points while an incorrect answer grants the player a negative resource such as radioactive waste. These negative resources accumulate and once the player has collected 3, he/she loses the highest level of improvement he/she has attained in his/her environment.
   d. Whether the player provides a correct or incorrect answer, he/she still possess the square and the accompanying resources (positive or negative) as long as the player is the only one occupying the square or when the player has the strongest pawn on the square.
   e. Once the player has placed a pawn and has answered a question it is the opponent's turn to place a pawn on a square and to answer a question.
   f. Once the two players have placed their pawns and answered a question, the computer counts the resources they have gained according to the squares they control. The total amount of resources they have gained for this round appears above each player's environment that needs to be improved, displayed on the left and right sides of the game board.
   g. According to the resources obtained, the players can build up their environment by acquiring an improvement. Improvements provide points, which are added to the total. Players can acquire one improvement per turn.
   h. Once these steps have been completed, the game progresses to the next round and the players repeat steps A to H.
5. Players have 12 turns to complete their environment by acquiring improvements. To do this, they must acquire 9 improvement- 3 level 1 improvements, 3 level 2 improvements and 3 level 3 improvements. To acquire an improvement, players must possess a certain amount of resources. The value of an improvement at level 1 is 2 resources (or 2 drops of water); an improvement at level 2 costs 4 resources (4 drops of water); an improvement at level 3 is worth 5 resources (5 drops of water) and 1 resource (1 flower). These resources are acquired by players at the end of each turn. Players can attain only one level of improvement per turn.
6. At the beginning of turns 3, 6, 9 and 12, the computer displays a special question (difficult scenario type question). Players compete to be the first to answer this special question. The first to click on the answer attains a special Action Card.
   a. If the player answers the question correctly, he/she will win an Action Card. The player must follow the indication present on the Action Card. Certain cards

requires an immediate action while others require an action to be completed on the following turn.

b. If the player's answer is incorrect, the opponent can answer and win the Action Card if he/she answers correctly. However, if the opponent answers the question incorrectly, neither player receives an Action Card.

7. Once a player has accumulated 3 negative resources (radioactive waste) as a result of incorrect answers, he/she loses the highest-level improvement in the environment. During a game it is possible to accumulate 3 negative resources multiple times and therefore lose more than one level of improvement.
8. A player can place his/her pawn on a square controlled by the opponent. Once both players have played, and there are an equal number of pawns on a square a question appears. The player who answers first and answers correctly wins this resource square for this round. If he/she answers incorrectly, the opponent wins the resource. This process occurs any time there is an equal strength on a square.
9. The game ends once the two players finish building their environment. If after 12 turns, no player has finished developing his environment, an additional turn appears. As long as a player has not completed his/her environment, players will be granted additional turns.
10. The game ends once one of the players has completed his/her environment. The first player to complete his/her environment obtains 150 points and wins the game. The results are displayed on the screen with an animation to present the results and the winning player.

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.

CONCLUSION

With the diversification of learning technologies, interest is growing more and more for the use of serious games in the distance education. The introduction of serious games into the learning environment of this new generation will favour learning. Knowing this, how can teachers integrate digital games into their learning environment?

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 & Sauvé, 2010.

Grade 10 and 11 students registered in a Web tournament (http://eau.savie.ca) will try out the Escouade H20 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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