Designing Multiplayer Educational Games with Online Generic Shells

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Abstract: A research and development program initiated under the aegis of the Centre for research in lifelong learning (SAVIE) developed a series of generic educational game design shells to enable teachers, trainers and community services workers to create educational games that provide effective learning conditions and which are adapted to their learning at a distance needs. These environments were based on the frame game concept and on the essential attributes of games as compiled within the framework of the longitudinal *Simulations and Advanced Gaming Environments for Learning Project (SAGE)*. This paper will first present the problematic that underlies our developmental research. We will then define the concept of the generic game shell. Then we will illustrate how the structure of the game of Parcheesi has become a generic game shell. Finally we will present an example of an online game.

Keywords: Design, Multiplayer, Game, Educational, Online.

Introduction

An applied research project funded the Initiative of the New Economy (INE-SSHRC) and the AAP (Industry Canada) which led to the development of generic environments for designing multiplayer educational games to equip teachers (K12 to university), professional educators, community development agents and company trainers who wish to create educational games adapted to their training needs while offering effective conditions for learning. These environments were built, on the one hand, after a literature review of research on essential game attributes (Sauvé et al, 2005 for the *Simulations and Advanced Gaming Environments for Learning Project* - SAGE) and, on the other hand, using the concept of frame games as developed by Stolovitch and Thiagarajan (1980).

This paper will first present the problematic that underlies our developmental research. We will then define the concept of the generic game shell. Then we will illustrate how the structure of the game of Parcheesi has become a generic game shell. Finally we will present an example of an online game: *STI: Stopping Transmission*.

Problematic

During the conference "Game developers 2006", Jerry Heneghan from the company Virtual Heroes mentioned that the market for educational games (or serious games) is gaining more and more ground in the world of game conception. The target audience of online educational games are principally those that we find in schools (elementary and high school), post secondary establishments and organizations (either public or private or even community organizations). What is happening in schools? Academic literature discusses a lot about the creative potential of new technologies such as educational games. What has been found, on the learning aspect, is that certain new aptitudes lay dormant when they are susceptible to being developed. It seems that schools do not explore the educational potential of these new uses. In most countries, in Canada in particular, the educational potential of video games does not give place to any reality seen in the field (Piette, 2005; Prensky, 2005a, b).

What is the profile of young people using games? Bain and Newton (2003) and Prensky (2005a) suggest that "the game generation" has developed a new cognitive style characterized by multitasked learning, which is usually not paid much attention to during the learning process, and a way of learning which relies on exploration and discovery. They support that the introduction of games in the learning environment of this new generation will help and support the learning process. Saethang and Kee (1998) and Shaffer *et al*. (2004) say that the use of video games modifies the way young people learn and inspires itself from a constructivist approach: the student first plays, then comprehends and finally generalizes to apply what has been learned to new situations. The authors also affirm that the role of the traditional teacher and the role of students are equally transformed into a game context: the student becomes active and participates in the construction of his knowledge base and the teacher collaborates to this learning process. Oblinger and Oblinger (2005) describe the profile of today's adolescents: "born" communicators, intuitive and visual. 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 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 young internet user wishes the following during the learning process: interactivity, interaction, active visualization, kinesthesis and immediacy. Van Eck (2006) adds that online games offer to the "Digital Natives" generation the opportunity to use inductive reasoning, to augment their visual abilities and their capacity to use many sources of information. The games allow the player to solve cognitive conflicts. "*Playing demands that you elaborate a constant cycle of hypotheses, of tests and revisions*"

How can games be integrated into the learning process? An investigation by Kaszap *et al.* (2005), among teachers from New-Brunswick and Quebec, specifies that educational games must take into account the qualities that the teachers are expecting from the offered online resources. O'Neill (2004) and Lamy (2005) indentifies that the online resources must be in direct link to the learning programs, they must be flexible so that they can be used efficiently in different learning situations, they must be adaptable to the particular characteristics (knowledge, level of language, etc.) of the students, and finally they must be friendly and easy to use. A study by Sauvé *et al*. (2005) of Web sites offering games has shown the following: (1) few games offer the learning content that answers to the pedagogical and technological criteria looked for by francophone teachers; (2) the existence of online games that deal with scholastic subjects, in particular mathematics and French; (3) most online games demand long download times and sometimes they are expensive; and (4) few sites offer information on the acquired leaning gained through the games themselves.

In order to respond to the needs of the teachers concerning online learning through the use of games all while taking into account how young people learn, a generic game shell has been created from the framework of the game of Parcheesi.

The Concept of the Generic Game Shell

The concept of the generic game shell has been developed by Sauvé (Sauvé *et al*., 2002) from the concept of the frame game elaborated by Stolovitch et Thiagarajan (1980). By frame game, we mean that it is a means of teaching which comprises a structure that generates learning activities supporting the use of diverse strategies, implying a conflict and a set of rules for the movement of players and criteria that ends the game by declaring a winner. This structure can easily be adapted to many different objectives and pedagogical content. Any game can be broken down into two main parts:

- The structure determines the way in which you play: the rules, the steps for the course of the game, the movements of the players, the challenges the players must face and the strategies they must employ to win. We have emptied the game of its contents so that the unique structure of the game can be laid bare. This structure, once clearly defined and analyzed, becomes a "frame", or for the means of our research, a generic game shell.
- The content is the information conveyed in the game: in the case of a pedagogical game, it is also the objectives being pursued and the abilities that will be developed by practicing the game. When the game is elaborated, you only need to insert the new content accompanied by the predetermined objectives to generate a new educational game which is adapted for a particular target audience.

It is the structure which will form, in the educational game conception environment, the necessary components for its programming. All existing games are generic shell games but you have to analyze attentively the game in order to flush out the structure from the content. In general, board games are easier to adapt into a game shell. There are many reasons why we are interested in them for our research: (1) they are generally known by the public at large (Who has not played Snakes and Ladders, or Tic Tac Toe or even Parcheesi!); (2) they offer simple structures with few rules which makes them easily adaptable; (3) and more importantly they correspond to the notion of a game by distinguishing themselves from simulations or game simulations since board games are constructed from the imaginary rather than from reality. Let us examine how the team has adapted the frame of the game of Parcheesi in order to make a generic game shell.

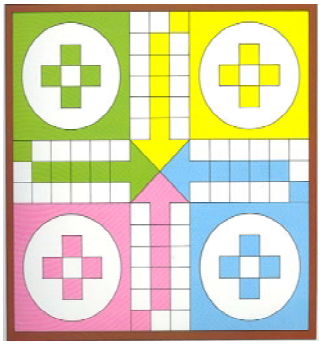
The Adaptation of the Frame of the Game of Parcheesi

The Web site of The Educational Games Central already proposes five generic game shells (http:/carrefour-jeux.savie.qc.ca) in three languages (French, English and Spanish). To develop a sixth game shell, the team relied upon an adaptation of an interactive pedagogical design model of McGriff (2000). Testing methods included expert internal validation and also a sampling of a target population as developed by Bordeleau and Perron (1994) and validated for online games by Sauvé et al. (2002) during the development of generic educational game shells. Let us examine how the game of Parcheesi has been adapted to become a generic game shell.

Structure Adaptation

First of all, we identified the original structure of the game of Parcheesi. This game is considered to have originally come from India and there exists many versions of this game: American, British (Ludo) and French versions (Petits Chevaux). Figure one presents the American rules and the game board.

Purpose of the game: be the first player to arrive with all four pawns into the final zone.
Number of players: 2 to 4
Length of game: 30 to 45 minutes
Game play:



1. Four pawns are then automatically placed into each team's personal space.
2. To get to the starting square of your personal square, a player must roll a six.
   A player that rolls a 6 is rewarded by another roll of the die.
3. The pawn advances along the arm of the cross in a clockwise fashion (in a counter clockwise fashion for the Indian version). A pawn that stops on a square already occupied by a pawn from another player forces that player to remove his pawn and place it back in his personal space. The pawn that was removed can only be placed back in the game if the player rolls a six at his turn in the game.
4. A pawn can only enter the end zone of the game by an exact die result. For example, if a pawn is five squares away from the end zone and the player rolls a six, the player must wait for his next turn to try and roll a five. But since the player rolled a 6, the player can move any other pawn or he can also liberate one pawn from the personal space.
5. Different throws of the die can be made to move different pawns. A throw of the die cannot be split in two; for example, a result of 6 cannot be separated to move one pawn forward 4 squares and another pawn moved forward by 2 squares.
6. A pawn that enters the end zone is removed from the board. The first player to remove all his pawns wins the game.

Figure 1: Original structure of the game of Parcheesi

Many adaptations were made in order to include pedagogical aspects and to make it into a generic game shell (http://egc.savie.ca); in particular, the game board, the rules, the directions, the learning activities, the pedagogical materials and the debriefing.

In general, the game board is rarely modified in a generic shell. In this case, we have taken into account the pedagogical demands and we have added a second route, which is much faster, to the initial route of the game board all while maintaining the number of spaces and the square shape of the board. The materials of the game, the number of pawns for each player or team (4) and the number of dice (2) is maintained. *Learning* cards (integration of the learning content), *Team* Cards (all teams play at the same time) and *Chance* cards (randomness to increase or diminish the chances of winning the game) have been added to answer to the learning objectives and maintain motivation.

The rules which govern the movement of players in the game have been improved (Table 1). These rules are accessible Online to the players whether before or during the game. The *procedure* rules describe the components of the game: the number of participants (players) or the number of teams, the role of each participant, their activities, the way they move and their possible movements, how the game starts, how the players proceed throughout the game, the scoring and the duration of the game. In our adaptation, we have added the following rules: 5 to 8, 10, 12 and 13 which deal with the actions of the players during learning activities and the movement of the pawns between the normal and rapid route.

The *end* rules explain how the game can be won and how the game ends. Generally, the end of the game determines a winner; however, there are certain games where there can be a draw. In Parcheesi, the end of the game happens when a player or team have completed the route. We have added a second way to end the game in order to respect the time constraints of a study period and this is shown by rules 2 and 14 of the adapted version. The rules of *control* describe the consequences for a player who executes an action which does not conform with the rules or a player who does not respect the directives and the preceding rules. In the shell of Parcheesi, we did not have any *control* rules link to the original structure but we have added movement constraints to the pawns, as shown in rules 5 to 7, when a team does not successfully pass a learning activity.

Table 1: *Structure of the Generic Shell of Parcheesi*

Goal of the game: there are two ways to win the game:

- Be the first player or team to move your four pawns into the end zone and also succeed in the final challenge.
- *After a set time for the length of the game, be the player or team with the most points when the game ends.*

Number of players or teams: the minimum number of players is at least 2 players or two teams of two players and the maximum number of players is 4 or four teams of four players.

Length of the game: When players are creating their teams, they can decide in advance what the length of the game will be. They can also decide not to impose a time limit to the game and simply let the game go on until one team has moved their four pawns into the end zone and have completed the final challenge.

Game Play

1. The game must be played with a minimum of two players each forming a team or a maximum of 16 players divided into 4 teams. Any other combination is also possible.
2. Before starting the game, teams have to decide how the game is to be won:
   - When all four pawns of a team have reached the end zone and correctly completed the educational activity.
   - When the predetermined amount of time has elapsed.
3. To start a game, the system records the number of teams and their make-up. Four pawns are then automatically placed into each team's personal space.
4. Who begins the game is purely random. Each team clicks on the dice. Whichever team rolls the highest number begins the game.
5. A team must obtain a double (1-1, 2-2, 3-3-, 4-4, 5-5, 6-6) for the system to move a pawn to the *Start* square. The team then clicks on the coloured pawn they want to move to the *Start* square. When a pawn is placed on the *Start* square, the team in question must attempt to complete an educational activity which corresponds to the color of their pawn:
   - If the team successfully completes the *first activity*, they can then roll the dice and move the pawn the appropriate number of squares along the fast track.
   - If the team does not complete the first activity, the pawn remains on the *Start* square and the team waits their next turn to try again.
   - If, on the next turn, a team completes the second activity, the pawn on the *Start* square is allowed to move along the regular track.
   - If a team does not complete the second activity, the pawn remains on the *Start* square. The team must then wait another turn to try again until they do complete an activity.
6. As soon as a team has moved a pawn, turns will happen as follows :
   - Players must complete an educational activity corresponding to the colour of the pawn which was moved during the last turn.
   - If the team successfully answers the question in the time allotted, the team then clicks the dice and can move a pawn the number of squares corresponding to the result of the dice. A team can also decide to bring a pawn into the game if the result of the dice allows it. Two pawns from the same team cannot occupy the same square. This means that a team cannot bring new pawns into the game if there is already a pawn on the *Start* square.
   - If a team fails an activity, they cannot click the dice. They will have to wait until the next turn to try to answer a question of the same category in order to be able to click the dice.
   - Once a team has finished their turn, the next player or team plays.
7. When a team moves their pawn (either on the regular or the fast track) and crosses a *Start* square, the team must successfully complete an educational activity. This has to be done even if, given the

results of the roll of the dice, the pawn crosses over the *Start* square. Successfully completing the educational activity is important since it determines which track the pawn will take, whether in finishing the move in progress or with regard to the next turn. If a team successfully completes an activity, the pawn may continue to move along the fast track. If the team fails, the pawn will move to the regular track. The same rule applies if the team lands on the *Start* square with an exact roll of the dice. When successful (in completing an activity), the team does not click on the dice but the pawn will go on the fast track at the next turn even if the team decides to move another pawn after having completed the activity. In other words, a pawn retains the ability to move along the fast track if the team has successfully completed an activity.

When a pawn crosses a *Start* square before embarking on a track that leads to the end zone, the team must yet again complete an educational activity. If the team does not succeed in this, the pawn remains where it is. The team must complete a new activity before being able to take the track that leads to the end zone. If a team completing an activity has a pawn that was interrupted in its movement because it crossed the *Start* square, the pawn can resume its movement along the track that leads to the end zone.

8. Each team who successfully completes an activity earns points. The points vary according to the amount of time taken to complete the activity.
9. If a pawn lands on a square already occupied by another pawn, the latter is sent back to the *Start* square. If the returning pawn lands on a *Start* square which is already occupied by another pawn, it is sent back to the team's personal space.
10. Each pawn can only reach the end zone on the board with an exact throw of the dice. The result of the dice has to be the exact number of spaces needed to reach the end zone (the center counts as one space). When arriving in the end zone, the pawn is removed from the game and the team gets 200 points.
11. When a team throw the dice and get a higher number than the number of spaces required for a pawn to reach the end zone, they have two options:
    - The team can decide not to move the pawn until they obtain an exact result and, instead, move another pawn which can move according to the result obtained by the dice.
    - They can move the pawn to the center square and move the pawn back corresponding to the roll of the dice. For example: say the pawn is two spaces away from the end zone and the team rolls a 5, the pawn moves forward 3 spaces and then moves back two.
    - The pawn cannot move back further than the first space of the track. If the pawn reaches this first space and still has moves to make, the pawn simply returns in the direction of the end zone with its remaining moves.
12. Once a team draws a *Team* card, all of the teams may compete simultaneously. The first team to successfully complete the activity earns additional points.
    - If a pawn of the winning team is on the *Start* square, it immediately accesses the fast track.
    - The team that drew the *Team* card does not lose their turn. Immediately after having played the *Team* card, their team may attempt to complete another educational activity.
13. When a team draws a *Chance* card, the team then performs one of the following actions:
    - *Win a Free Start.* This card allows the team to move one of their pawns to the *Start* square, which requires that the team immediately attempts an educational activity. If the *Start* square is already occupied by one of the team's pawns or if all of the team's pawns are currently in play, the team may keep the *Chance* card and use it later on in the game to position one of its pawns on the *Start* square.
    - *Exact Throw.* This card allows the team to move one of its pawns (any pawn which is currently in play and not on the *Start* square) into the end zone. If the team has only one pawn in play and that pawn is on the *Start* square, the *Chance* card is kept by the team to be used later on in the game to move one of their pawns directly into the end zone.
    - *Go back to Start.* This card moves a team's pawn back to the *Start* square. If the square is already occupied by another pawn, the latter returns to the personal space of the pawn's team. If the team has only one pawn currently in play and that pawn is on the *Start* square, the card is kept by the team and the pawn will have to return to the *Start* square the next time it is moved. If the pawn associated with the card is removed from play before the card is played, the team puts the card back (it is discarded).
    - *Fast-tracking.* This card allows a team to move the pawn used to pick the card from the regular track to the fast track without having to complete an educational activity, if the pawn is on the *Start* square or past it.
    - *A maximum of two* ***Chance*** *cards* can be retained at any one time by a team. If a team has two *Chance* cards in reserve, any new Chance card will replace the first Chance card held.
14. Game over:

- When a team moves all four pawns into the end zone, successfully completing an educational activity, it wins. If a team picks a Team card as the final educational activity, the team wins the game only if they complete the educational activity. If the team does not correctly answer the question, the team must wait till their next turn to try to successfully complete another educational activity and win the game.
- When the allotted time has run out, the team with the most points wins the game.

In board games, there are no distinctions between the rules and the directives as in computer games. In a board game the players themselves move their own pawns on the board. In a computer game, a game engine moves the pawns, identifies which player will start the game and the player who follows, etc. These directives, which we distinguish from the rules, only have as a goal to facilitate comprehension for the players on the constraints imposed by a game engine. For example, it indicates the name of the player that must click the dice or the player that must attempt a learning activity in order to obtain points, etc. No other player can act in the game until the identified player has finished their turn.

Finally, this shell allows for the generation of team games supported by a multiplayer platform (ENJEUX, http://enjeux.savie.ca) (Fig. 2) and also provides real time communication tools (audio or videoconference) according to the equipment that the players possess (headphones or webcam) at the moment they access the game.

Figure 2: An example of a multiplayer platform (ENJEUX)

Content Adaptation

In general, the content of a game can be completely modified. First of all, we have added learning activities to the shell in order to respond to certain demands previously stated. The predetermined formats linked to eleven types of activities have been integrated and are presented in the form of closed questions (multiple choice, True or False) and open questions (long or short answers), illustrated exercises, audio or video, cases to be analyzed, logical sequences to be completed, etc.

Other tools have also been integrated into the shell. Tools for the conception of pedagogical materials in the form of learning objects have been integrated. This material is available for players either before or

after the game. The creator of the game can activate a whiteboard for debriefing and also for feedback from the players. This debriefing is strongly recommended because it is an important step to the integration of the knowledge, emotions and attitudes developed by the game.

Ultimately, the generic shell of the game Parcheesi proposes to the creators all the tools necessary to define the game parameters, generate the directions and the rules concerning the movement of players, constructing learning activities and the pedagogical materials, establish the criteria about how the game ends by declaring a winner and the elaboration of debriefing, evaluation instruments so that the game is always revised and also tools to measure its effectiveness on learning.

An Example of an Online Application

Starting with the Parcheesi shell game, two health specialists worked with the research team to develop a game on sexually transmitted infections. They have developed 73 learning activities which are grouped into four aspects of STI (Fig. 3): (1) prevention : information on the correct ways to break the cycle of STI transmission (types of condoms, identification of risky behaviours, etc.); (2) prevalence: the state of the situation of the importance of the number of people infected or carriers of an STI, and information on the infectious vectors themselves (their nature, their visible or invisible effects); (3) transmission of STI : information on how the different types of STI can be transmitted. This category allows the players to question the widespread myths and beliefs already well anchored in the population at large and (4) treatment: information on the ways to heal (or coping with) sexually transmitted infections. This section also includes information on ways to prevent transmission to other people when you are infected; for example, abstaining from certain types of more risky behaviours during the treatment period and also information on what to do when you think you have been exposed to an infection. To these questions, the research team has added about 20 role playing activities which permit young people to express and reflect on STI which will modify their attitudes and behaviours on a daily basis. (Fig. 3) illustrates an example of an activity that includes a viewing of a video clip:

Figure 3: An example of an activity with a video

The adaptations brought to the original structure permits the integration of the learning content needed from elementary schools to universities. Parcheesi is a generic game shell that works well with simple or complex learning: acquisition, integration, and structuring of knowledge, attitude and behaviour modification, evaluation, etc.

Conclusion

The risk of acquiring a sexually-transmitted infection (STI) is unfortunately part of today's reality for adolescents all around the world. Numerous ways have been developed to inform teenagers and other at-risk groups of the dangers associated with various types of infection. The objective is to document the use of educational games with young people from different backgrounds and to assess the results of their behaviour. To this end, we will use a "predisposition to health" model which sheds light on three

types of factors: (1) a predisposition to act which is determined by an individual's perception of his or her vulnerability towards STI's and the perception of the gravity and dangers of STIs; (2) the perception of practical and accessible solutions comprising an assessment of personal gain to be obtained from certain actions and an assessment of the scale of the obstacles preventing action and the cost of these actions and (3) action-inducing events like games.

The game *STI: Stopping Transmission* will be tested in the fall of 2007. During the experiment, different variables will be measured with the help of a questionnaire and a monitoring system integrated into the game environment: structuring and integration of knowledge and also attitude and behaviour modification towards STIs.

Being pioneer work in the development of generic shells for educational games on the Internet (6 shells are now available), this developmental research, under the aegis of the Center of expertise and research of SAVIE and the SAGE network, gives the possibility to health professionals to rapidly develop educational games which will be available to both teachers and students in Canada as well as all around the world. To know more and to become part of these game creators, register yourself at SAGE: http://www.sageforlearning.ca/ and at The Educational Games Central at the following Internet address: http://egc.savie.ca.

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