In & Out in 60 minutes : How to get an educational game up and running in no time

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Abstract: The advent of the Information Highway has heightened interest in the use of educational games for learning in both schools and universities and the workplace. Studies by Sauvé and al. (2004, 2003, 2002) and Baranowski (2003) show that games create favourable conditions for learning, namely via feedback, interaction, active learner participation, motivation and skills development. To promote the use of games, a longitudinal research project, *Simulations and Advanced Gaming Environments for Learning*, (SAGE) is examining, among other things, how generically-designed educational gaming environments for learning take into account learner needs and training content while providing effective learning conditions. This paper presents current progress and relevant concepts; the "frame game" concept, an example of the generic shell for the game *Concentration*, the methodology and testing results in relationship to the pedagogical and technical quality of the games developed by teachers through e-learning and in-class educational contexts.

Mots-clés : Educational game, generic shell, frame game, pedagogical innovation, e-learning.

INTRODUCTION

The advent of the Information Superhighway is heightening interest for the use of games for education, whether initial or ongoing (Johne, 2002). Studies show that games introduce favourable learning conditions, namely feedback, interaction, the active participation of learners, motivation and skill development and strengthening.

The task for any teacher is to create favourable learning conditions so that adult learners may acquire desired skills. To properly carry out this task, the teacher must, among other things, choose the appropriate pedagogical method in order to remove any learning obstacles. Despite the fact that educational games offer definite advantages, few teachers and trainers actually use this method for a lack of appropriate material for their particular teaching or training circumstances. Therefore, in order to make games easier to use, a research and development initiative, now called *Educational Games Central*— begun in July 2000 and funded successively by Francommunautés virtuelles (Industry Canada), Office of Learning Technologies (HRDC), the Inukshuk Fund (Industry Canada) and the Initiative on the New Economy (SSHRC) — has shed light on a number of variables. In this progress report, we will focus mainly on research results dealing with the educational and technical quality of the games that were tested in schools (from K-12 to university) based on five computerized frame game shells. Firstly, however, we will discuss the progress of the study as well as a game which has been adapted to the needs of college-level education and the methodology adopted.

THE STUDY : AN UPDATE

Several meta-analyses of research studies and results have described the effectiveness of games and simulations for cognitive, affective and psychomotor learning (Jones, 1998; MCLI, 1999; Jubiebo & Durnford, 2000; Mumtaz, 2001; Reuss & Gardulski, 2001; Shapiro & Shapiro, 2001; Bartholomew and al., 2001; Sauvé and al., 2002, 2003.2004; Garris and al., 2002; Baranowski and al., 2003). According to these studies, games motivate learners offering immediate feedback, increasing active learner participation, reinforcing knowledge, contributing to the development and application of acquired skills and the transfer of learning and finally, influencing behaviour and attitudinal changes.

St-Germain & Leveault (1998) and MCLI (1999) also explain that one of the success factors in learning with computer games is the degree of interaction between the user and the system; in other words, the degree of involvement of the learner in the environment. Kinsy and al. (1996) add that, to date, the Internet is one of the most efficient broadcasting media ever, offering a high degree of interaction and increasing retention and satisfaction levels of individuals who learn with games. Rieber & Matzko (2001) and MIT (2002) conclude that games are powerful learning mediators throughout an individual's entire life. Although games apparently demonstrate effectiveness, several authors mention certain pitfalls that deserve to be investigated more thoroughly through research. Alessi & Trollip (1991) claim that educational games developed using information and communication technology (ICT) often have design flaws and that the learning environment created is rarely effective. Thiagarajan (1998) and Hourst & Thiagi (2001) observe that games lack sufficient testing to establish their technological performances and their effectiveness and efficiency in relationship to learning. Bartholomew and al. (2001) emphasize that the poor development of educational tools, such as games, is due to a lack of linkage between theory and practice and operational strategies. Therefore, these analyses often reveal a degree of disparity in the results reported and, in their research, authors ponder the cause of such disparities. They note that certain factors have an impact on a game's effectiveness:

- Research-related variables: weaknesses in the conceptual framework of studies, deficient methodology, a lack of linkage between theory and practice, etc.
- Game designer-related variables: the designer's ability to effectively transfer content into a game, game selection with regard to the type of learning sought, the ease with which simple and easy-to-understand game rules are drafted, etc.
- Individual learner characteristic-related variables: for instance, a learner's educational and socio-economic background, learning profile, etc.
- Procedure-related variables: that is, the manner in which the teacher prepares himself to introduce the game, his involvement while the game is in progress (before, during, and at the end) and the manner in which he leads the discussion during the after-game review (in person or at a distance),
- Game-related variables: the pedagogical aspects (feedback, motivation, interaction, etc.) and the technical aspects (uniformity, presentation, simplicity, adaptability, etc.).

Furthermore, a series of Web sites offering games were analyzed (Sauvé & St-Pierre, 2003) providing the following findings:

- There are on-line educational games that deal with certain school subjects, Mathematics and French, among others.
- Many on-line games involve tedious download times or are expensive.
- Very few games with learning content meet the pedagogical and technical criteria set by educators.
- There is an absence of computerized game shells offered on-line for the development of educational games adapted to the needs of K-12 and postsecondary educators.

This review has shown the extent to which it is difficult for teachers to find pedagogically-based games suited to their needs on the Information Highway. Teachers have no alternative but to choose between, on the one hand, using the games that are available (limited in both scope and content) or, on the other hand, creating games from scratch. The latter alternative is not feasible, given the overwhelming amount of time and energy required to do so. This is where the concept of the *computerized frame game* comes into play

because, due to its flexibility and simplicity, it provides an efficient solution to the problem of game development.

THE FRAME GAME CONCEPT

A frame game consists of educational content endowed with a structure that generates learning activities, promotes the use of various strategies and involves conflict. A set of rules governs player moves and criteria which allow players to finish the game by declaring a winner. Such a structure is easily adapted to a wide range of pedagogical objectives and content (Stolovitch & Thiagarajan, 1980; Hourst & Thiagarajan, 2001; Sauvé & Chamberland, 2003). Any game can thus can be broken down in two main parts:

- The structure determines the way the game is played: the rules, the stages of the game or the moves of the players, the challenge they face and the winning strategies they can deploy. As for the game itself, what we do is to "hollow out" its content and expose its underlying structure. Once this structure has been identified and analysed, it becomes a "frame".
- The content refers to the information conveyed during the game. In the case of games of a pedagogical nature this also involves the objectives sought and the skills that will be developed by playing the game. So, when the game is being worked out, you only need to slip in a new content with predetermined objectives to generate a new game with an educational potential adapted to a special target audience.

(insert figure 1)

Therefore any existing game is a potential frame game. However, a game must be closely analyzed to see if the structure can be separated from the content. A good game can be recognized by the harmony between structure and content; the frame game fulfills this requirement. But what makes the frame game especially useful is that other content can be substituted for the original content, while being perfectly compatible with the structure. It is this fundamental characteristic, that of content interchangeability, that makes the frame game such an interesting educational tool. Figure 2 illustrates content interchangeability. In this way, a frame game can often respond to a large number of different educational needs. With one frame game, an infinite number of new games can be created, as many as required by students and educators for virtually any educational content.

(insert figure 2)

AN EXAMPLE OF ON-LINE PARTICIPATION

Applying the frame game concept, five computerized, user-friendly generic shells were developed for the on-line modification of learning content. Teachers are hence able to create new games adapted to student needs. Help bubbles were developed to appear on demand to assist teacher using these shells throughout the content integration process. In order to better illustrate this point, see the rules and materials in figure 3 for an adapted example of the game *Concentration* (a mnemonics game). As figure 3 shows, a post-secondary biology teacher adapted the framework to develop a new game in under one hour. The objective in developing the game *Memor-Os* (Bones of Contention) was to teach terminology dealing with different parts of the human skeleton. It should be pointed out that the teacher simply modified the wording of rules and replaced the game cards in order to teach the various bones in the human skeleton.

(insert Figure 3)

THE METHODOLOGY

Our research strategy includes systematically using existing knowledge and substantially improving an already existing methodology (a more effective use of on-line games in an educational context) and at improving the computerized generic shells, an instrument used to create educational games adapted to the needs of the learning environment (Contandriopoulos and al., 1990). In this applied research context, the collaborative approach was privileged, which "aims at paving the way between the worlds of research and practice within the specific framework of the teaching profession" (Desgagné, 1997: 372). Finally, the case study technique was retained because the main objective was to document the introduction of educational games in various learning environments and to assess the results obtained (Leedy, 1995).

Aspects under study

For the purposes of this paper, the pedagogical and technical quality of the games was the focus, especially the following elements:

- Did the game motivate the learner?
- Did the game allow for immediate feedback?
- Did the game offer a high degree of interaction between the user and the system, or between several users and the system, thereby contributing to successful learning?
- Did the game increase the learner's active participation?
- Did the game meet the following technical criteria: uniformity, content presentation, appropriate language and legibility?

Three hundred and eighty-two learners from the three levels of public education institutions participated in the testing: 175, primary; 108, secondary and 99, post-secondary.

Data collection tools

The case study method involved the use of several data collection tools (Stenhouse, 1980; Dolbec, 1999). For the learners in this study, the following tools were used: (1) a questionnaire concerning learner attitude towards the game and the pedagogical and technical qualities of the game, (2) an account of the

player action during gaming using a computer-tracking tool; and, (3) an interview on the various aspects of the game: motivation, interaction, active participation, etc.

The quantitative data was processed using different descriptive analysis techniques (frequency, average, standard deviation, percentages, etc.). As for qualitative data, it was processed according to the different content analysis methods (L'Écuyer, 1990; Paillé, 1994).

ANALYSIS OF THE CASE STUDY RESULTS

The games developed by teachers were used for various pedagogical purposes: revision, training, test on knowledge following the learning of a new concept (formative assessment) or training. Out of the twenty-two games tested, eight were developed for the primary level, five for the secondary level, nine for the post-secondary level (including one in a context of distance learning). In this presentation we will dwell on the variables related to the game itself.

Pedagogical and technical quality of educational games

Interesting information was gathered on the pedagogical and technical quality of the games through observation of the players, an interview and a questionnaire concerning the game they had played. All participants except one totally agree, or agree, that the game could be used as a learning aid by teachers.

Five pedagogical variables were taken into account in evaluating the pedagogical aspect of the games developed with generic shells: learners' attitude towards the game, feedback, interaction, the active participation of learners, motivation and knowledge consolidation. As for the technical aspect, it was assessed in relation to the rules concerning uniformity, informative presentation, adaptation of the environment to the users' language and legibility.

- ***Attitudes towards the use of the games for learning purposes***

Social cognitive theorists suggest that positive role models and opportunities for successful experiences help to develop self-efficacy and positive attitudes concurrently with knowledge and skills (Bandura, 1986; Kaufman and al., 2000; Benbassat & Baumal, 2002). Generally speaking, the attitude of the participants towards educational games is positive (92%) and this even though 56% of them say that they had never played educational games on the Web as a learning tool.

- ***Feedback***

Feedback is one of the characteristics most often mentioned by researchers in relation to educational games, especially in terms of speed and quality. Feedback can be defined as a "process induced automatically following a disruption to prompt remedial action in the opposite direction" ("Le Petit Larousse illustré", 2002: 888-889). Computer games enable one to receive immediate feedback either from the system or from the other learners. (Hourst & Thiagi, 2001; Reuss & Gardulski, 2001; Rosas and al., 2002).

The results of the study show that, regardless of the educational level and training environment, 96% of the learners are very satisfied with the type of feedback provided by the games, and 4% are satisfied. More specifically, the games that provide personalized feedback were better appreciated (100%) than the games that only provided feedback by default (66%). The respondents emphasized that personalized feedback towards the game (an option offered to the trainer) helps with learning: " […] we remembered

the subject better, because when we had wrong answers it (the system) gave the right answers". "identifying the reason why we answered incorrectly allows us to understand better".

- ***Interaction***

Literature shows that computer games offer a high degree of interaction between the user and the system, between several users and the system and between the users themselves. Hourst & Thiagi (2001) note that the games contribute to the development of interactions between learners, as well as better group cohesion. Shapiro & Shapiro (2001) conclude that the use of the game contributes to interaction between the learners, discussion and idea co-ordination. The game then becomes a means of communication and co-operation and promotes active learning. Kinsy and al. (1996) explain that, to date, the Internet constitutes one of the most effective broadcast media to offer a high interactivity level and increase the retention and satisfaction level of learners with the help of games. Educational research frequently stresses the use of new technologies to promote collaborative learning (Ritchie & Hoffman, 1996; Marton, 1994). It should be pointed out that this type of learning generally stirs up the motivation of a majority of students (Reuss & Gardulski, 2001).

Results show that 95% of learners consider that the game allowed them to interact with other learners, and 5% could not answer (namely, the primary level children). During our observations with the primary level children we noticed that the game fostered interaction and co-operation among learners. As a matter of fact, even though the students played against one another, they thought out loud and discussed among themselves about the choice of answer to give. A fourth-grade student even explained to his "opponent" what a parallel line was. However, we should point out that as the game draws to an end, this co-operation subsides.

- ***Active participation of learners***

The involvement of learners in the environment guarantees the success of their learning (St-Germain & Leveault, 1998; MCLI, 1999; Ortmann and Price, 2003) The game promotes the active participation of the learners by "forcing" them to participate and put into practice the notions studied, and by demanding from them cognitive commitment and constant attention (Ripp, 2001).

Through playing the game, 88% of the learners consider that they actively participated in their learning, 12 % of the participants, mostly from the college level, felt that they more or less related to the game they played. In all learning environments the results mostly bring to light the following points: a higher degree of retention relative to the subject matter, memorizing of information, acquisition of new knowledge, revision of subject matter and learning motivation. In this respect, here are a few comments by some participants: "Very helpful for learning and reviewing the subject matter", "This game was fine to make us study", "It helps get the subject matter into my head", "It's very good, it helps us learn", "Before playing the game I didn't know what was a perpendicular line, now I know ".

It is very interesting to note that 55% of the players would have liked the games to include more questions: "Add more questions", "Vary the questions because they tend to always be the same", "The only thing is that there were not enough questions, the same questions were always repeated". When the games developed by the trainers were studied, all of them except one had used only a minimum number of questions at the time the game was created.

- ***Motivation***

Motivation to learn and to participate actively in learning communities is influenced by both the relevance and utility of the learning, and by learner enjoyment (D'Alessandro & Kingsley, 2002.) Motivation is an important learning ingredient. In this study we define motivation as follows: " […] the effort or energy a person is prepared to spend to perform a given learning assignment." (Viau and al., 2003). The learner's motivation to perform a given learning assignment depends on the importance attached by this learner to the final goal, on the learner's interest in the assignment and on their perception of the extent of such task. Brien (1997) mentions that individuals are attracted by the performance of tasks that are likely to bring them positive emotions in the short-to-medium term. Among teaching situations that are likely to arouse the interest of the learner we find learning activities that trigger emotions related to the need for belonging and for seeking new challenges, especially peer tutoring, educational games, tournaments, simulations, etc. Games in one form or another therefore constitute a most interesting motivational element. They help sustain the students' interest and increase their learning satisfaction (Wlodkowski 1985, Hourst & Thiagi, 2001; Reuss & Gardulski, 2001; D'Alessandro & Kingsley, 2002; Rosas and al., 2002). Moreover, because of the nature of the game itself the learner reacts not only intellectually but also emotionally. This form of learning, with a positive emotional involvement, is very effective.

The results of the case study reveal that the participants considered that the game gave them a motivation to learn (84%), 10% were not very motivated, 2% were not motivated and 4% could not answer (mostly primary grade students). On that subject, here are a few comments made by learners: "I never would have thought I could learn so much by playing a game". "I played at home with my friends, usually I don't like to do homework, I could hardly believe it". "Before I played I felt I could not calculate, but now I feel I can".

- ***Knowledge reinforcement***

Generally speaking, the games speed up and reinforce learning (Rosas and al., 2002; Dempsey and al., 2002; Reuss & Gardulski, 2001; Fonseca and al., 2000). They have an impact on the development of various skills according to the format and content conveyed. For example, they contribute to the development of interpersonal skills such as negotiation and co-operation (Ripp, 2001); of cognitive skills such as memory retention, procedural learning (Hourst & Thiagi, 2001) mathematical co-ordination and problem solving ability (Bricker *et al*., 1995).

In all learning environments, 89% of the participants consider that they experienced and learned new things, "I learned some things that I had not remembered very well"; "This allowed me to review the subject matter"; "Seeing the same questions during the game helps increase the retention level with regard to the subject matter." In a work environment, some learners had misunderstood the procedure that had to be done. The game allowed them to realize their mistake.

- ***Technical quality***

When the generic shells of the game were created, several parameters were weighed and tested in order to assess the technical quality of the games developed by the teachers/instructors, namely:

- the introduction of *signalling* and *layout standards* making browsing easier for learners during the game: permanent display of a scroll bar at the top of the screen, development of a series of "cuecons" common to the different game elements, quick retrieval of the rules, instructions, learning contents, etc.;

- the use of *objects and controls* that the game players are familiar with, especially: dice, pawns, cut and paste, cancel and aid functions, so that users do not have to learn a new environment and a new learning content at the same time;
- *the display of information on the screen* which takes into account, on the one hand, the information users need to perform their activities and, on the other hand, the manner in which the users perceive and understand these elements of the system. Therefore, in the games, the most important information appears at the forefront. For additional information the user has to click on a help bubble to learn more about the subject. The path must be the shortest possible between two elements. Kristof & Satran (1995) stress the importance of having direct access to information to minimize the use of mouse "clicks" and make browsing easier;
- the available option, *adapting the game to the language of users*, allows teachers, on the one hand, to review the wording of the instructions and rules and, on the other hand, to formulate questions and feedback adapted to the target audience;
- the *emphasis given to the key-elements* (bold type, colour, character size) of the content displayed on the screen, and the fact that these elements actually help users perform the tasks and get their bearings in the game;
- the use of *guides, references and markers* to guide users in their approach of the game as needed and let them experience learning, including permanent access to the game rules and the instructions displayed according to the moves of the players, etc.

Overall, the participants assessed as very satisfactory (86%), satisfactory (7%) and not particularly satisfactory (7%) the various technical parameters of the games developed using generic shells.

Conclusion

Despite the limits inherent to this case study (small sample, use of games with various learning contents,) the results are consistent with the findings of several studies, namely that information highway educational games provide conditions conducive to effective learning (Viau and al., 2003), in a way that is significant to learners and easily integrated into other activities, that represents a challenge and requires a cognitive commitment, that allows learners to interact and co-operate with one another, that involves clear instructions and takes place over a sufficiently long period.

Acting as a pioneer in the development of generic shells for educational games on the Internet, this developmental research allows trainers in the work environment, workers in the job search community environment and teachers of various professional bodies to rapidly develop educational games while helping establish a game bank supplied by experts and teachers. This bank will be accessible to the entire community of teachers and learners in Canada and all over the world. It is up to you to be part of it by enrolling in the Carrefour virtuel de jeux éducatifs at the following Web address: http://carrefour-jeux.savie.ca

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Words count : 4977

Biography (100 words) : Dr. Louise Sauvé is Professor of Educational Technology at Télé-université (Québec). She is Head of the Center of expertise and research for lifelong learning (SAVIE); her research focus is primarily on educational games and simulations, training needs, learner profiles, methodologies for interactive, online, multimedia design environments and distance education. Recipient of the Canadian Association for Distance Education Award (CADE, 2000) for her work on the Information Highway and the Philippe Marton Award (1997) for her contribution to field of educational technology, she has to her credit more than 120 scientific papers and workshops, 15 distance education courses, approximately sixty scientific articles, over a hundred reports translated into several languages, about twenty major research papers and contributions in a dozen edited books.

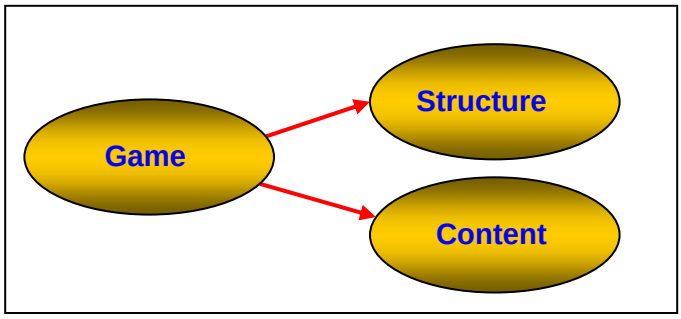

Figure 1. Frame game

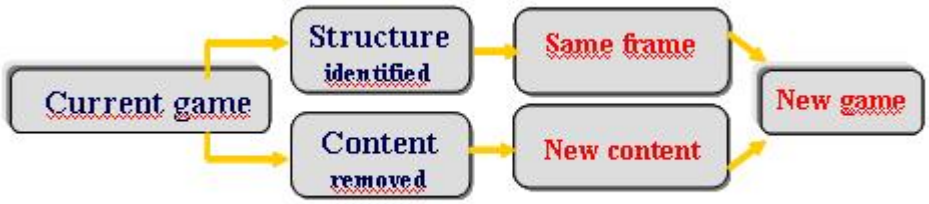

Figure 2. Content interchangeability

Rules

1. The computer deals the cards randomly and face down.
2. The first player is chosen randomly.
3. The player whose turn it is to play is identified by a green tab next to their name.
4. In turn, each player clicks on two cards to reveal their underside in order to make a match.
5. The computer removes each correct match (an illustration and a term) from the game until none remain.
6. It is possible to play again automatically or to exit the game by clicking on *Exit*.
7. The winner is the player with the greatest number of points and the fewest moves.

Based on the player's decision, the score will be complied as such:

8. If the player makes a proper match between the illustration and the term and he correctly identifies it, he scores one point and the cards disappear.
9. If the player makes the proper match between the illustration and the term but he incorrectly identifies it, he loses one point and the cards are returned.
10. If the player makes a wrong match between the illustration and the term but he correctly identifies it as such, he does not lose any points and the cards are returned.
11. If the player makes a wrong match between an illustration and term and that the player identifies it as correct, he loses one point and the cards are returned.

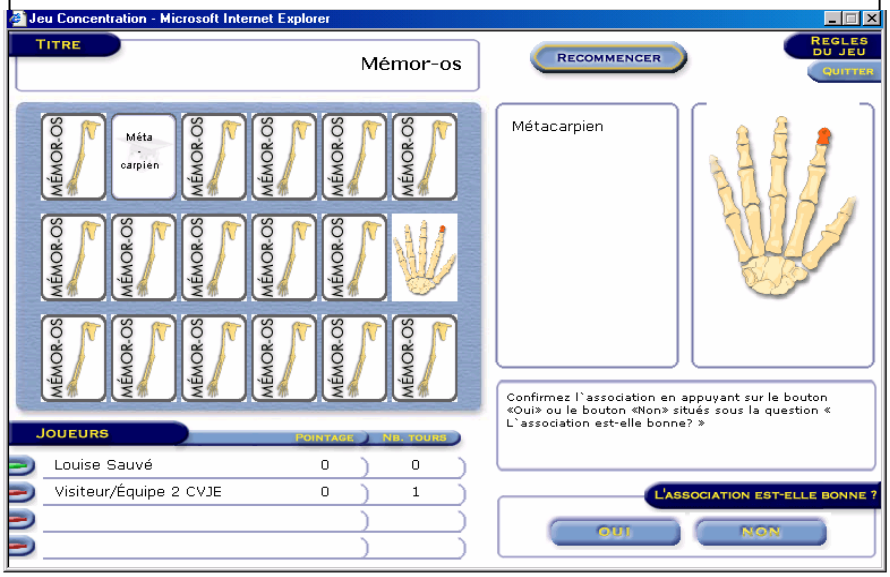

Figure 3. Adaptation of the game Concentration for learning about the human skeleton.