When games meet learning

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Eric Sanchez, *eric.sanchez@usherbrooke.ca*
CREAS, Université de Sherbrooke, Qc Canada
INRP/Ecole Nationale Supérieure de Lyon, France

Abstract
In a context characterized by a growing gap between youth digital culture and school culture some have claimed that games could "have the potential to change the landscape of education" (Shaffer, Squire, Halverson, & Gee, 2005). This paper examines the arguments and objections to using games for educational purposes. Firstly, we state that making a connection between gaming and learning is not an innovative idea, as early researchers demonstrated the potential of games in child development. Secondly, we establish arguments to consider serious games as learning environments, (or *didactical situations*) prior to artifacts, Thirdly, in view of the fact that the content of games can be considered as metaphors of real situations, we stipulate that teachers may address the question of the relevance of this content. Fourthly, we discuss the main arguments usually emphasized by researchers to consider that games have the power to motivate students, Fifthly, we state that games can be considered as a space of reflexivity where the learner/player is autonomous and develops skills. However, we emphasize the crucial role of the teacher in a Game-Based Learning approach.

Keywords
Serious Games, Information and Communication Technologies, Game-Based Learning, ill-structured problems, complexity

INTRODUCTION

Digital natives, Net Generation, Y Generation, C Generation... many terms are used to qualify youths who were born in a world where digital technologies – especially the Internet – are of a great importance. These terms issue from a huge body of studies that focus on youth digital culture and that illustrate a wide consensus which considers that new media are altering how youths learn and socialize (CEFRIO, 2011; Ito et al., 2008; Lenhart et al., 2008). They also demonstrate that teachers face a new audience, one engaged in gaming, multitasking and social networking. Indeed, digital natives use the Internet to create content, share knowledge and expertise, consume cultural goods or remix existing material (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006). However, schools are focused on training autonomous problem-solvers, whereas there is a growing need for teamwork and collaboration skills in multidisciplinary networks to solve the problems faced by our more and more complex world. Thus, a growing gap separates youth digital culture from the mainly academic school culture. There is also a gap between how youths are educated and the new and complex challenges faced by human beings, which educators ought to take into account.

Within this context it has been advocated that Game-Based Learning should be considered as an alternative pedagogy adapted to new learners and different initiatives have been taken to promote the uses of serious games in schools or universities (Wastiau, Kearney, & Van den Berghe, 2009). Indeed, games meet learning and a growing body of research addresses questions such as the effectiveness of games as learning tools or how video games can be designed to facilitate learning. Starting with this, this paper examines the arguments and objections to using games for educational purposes.

Gaming & learning

In early works, Piaget and Inhelder underlined the semiotic function of play (*i.e.* the power to evoke, with signs and symbols, objects or situations that are not actually perceived (Piaget & Inhelder, 1966). Thus, play becomes symbolic and a game can be considered as a space where activities are not driven by adaptation to reality but by the assimilation of reality by ego without any constraints or penalties (*ibid.*). According to a psychoanalytic point of view developed by Winnicott (Winnicott, 1971), playing occurs at the interface between the inner world of a child and his/her external reality. By playing, the child enters an intermediate area of experience where reality is not a constraint but is reorganized according to his/her expectations. This area relates to a potential space and playing serves as the basis for creativity. As a psychologist, Vygotski considers games as "imaginary situations" (Vygotski, 1966) created by children. In a game, a child learns to guide his/her behaviour according both to the immediate perception of the situation and to the meaning of this situation. According to Vygotski, "play is the source of development" (*Ibid*.).

In addition, the link between gaming and learning has been demonstrated for the youths of mammals. Ethologists (Jacob & Power, 2006) argue that by gaming, young animals develop sensory-motor schemes and a better knowledge of their surrounding environment, which helps them to escape from predators (*ie*. a young antelope jumping and running in the savannah). Gaming is also involved in the construction of social organisation and hierarchy (*ie*. fighting of young wolfs to determine the alpha male) and in the development of cognitive skills (*ie*. young bonobos playing to solve problems). As a result, gaming can be considered as a biological function that plays an important role in making young mammals better suited to their habitat.

Following what has been said above, one can argue that making connections between gaming and learning is not an innovative idea. Indeed, educators have a long tradition of using games in their classrooms (Brougère, 2000). Nevertheless, this idea is now coming into the limelight again, as innovative and powerful digital technologies offer new opportunities to design more and more realistic virtual worlds or to implement games into mobile devices.

Defining the term *game* is not an easy task, the word being used for concepts related to very different contexts such as sports, arts or entertainment. Thus, Brougère (Brougère, 2005) proposes a set of criteria to determine if a situation is a game or not. According to this researcher, a game is a meta-activity, a model of an ordinary situation. As a result, the consequences of the play are minimized (frivolity criteria). The player is allowed to take decisions (autonomy criteria) and the results of the play depend on these decisions even if uncertainty always remains in regards to the ending (incertitude criteria). The freedom to take decisions is limited by norms and conventions shared by the players (rules criteria). This set of criteria is valuable to implement Game-Based-Learning situations in the classroom and to distinguish such situations from Problem-Based-Learning and Project-Based-Learning that are different but close educational settings.

This paper focuses on "serious games". This term was probably first introduced by Abt (Abt, 1970). Abt considers that a game is a "context" and defines serious games as games that have an "explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement". Since then, the term has been widely spread to name computer games designed for applications aiming at "serious" purposes such as advertising, recruiting employees, training staff and learning. This term has multiple meanings but it is mainly used to name computer games designed for utilitarian objectives. But following Dewey (Dewey, 1934) who states that as an artifact, a piece of art is not art, that art is fundamentally interactive and experiential, we consider the sense of play emerging from the interactions between a player and the game as an artifact. Therefore, we can state that it is worthwhile to adopt a point of view that considers games as situations rather than artifacts (Sanchez & Jouneau-Sion, 2010) and then to focus our attention on the interactions that emerge from the situation.

Games as metaphors

As a meta-activity, a game, as artifact or situation, entails a model of a given reality. The model that is implemented in the game results from the transposition of a real situation into the context of the game. Therefore, this embedded model is rather a set of concepts and values selected by the game designer than by reality itself. As a result, games can be considered as metaphors of reality and they are close to simulations and microworlds. In addition, a validity domain limits games and one of the main arguments underlined by teachers who don't use computer games for their teaching is the lack of relevance of the content. Indeed, there is a risk to *encourage students "to get used to manipulating a system whose core assumptions they do not see and which may or may not be 'true'"* (Turkle, 2005). For example, the knowledge implemented in *Spore* - a video game that has had great success - is clearly based on intelligent design theory. *Spore* does not respect the Darwinian conception of evolution as *Spore* allows the player to be an intelligent designer by creating new life forms and making them evolve. Spore is mainly used for amusement but some teachers use the game to teach intelligent design (Sanchez & Prieur, 2009). It is worth noticing that Spore is also used by teachers who teach Darwinian theory (*Ibid*.), but, in this case, the game experience is followed by a debriefing session to help students deconstruct the model and compare it to modern and scientific theories.

The relevance of the context is an issue that can be addressed for many games. For example, regarding games designed to develop students' awareness about sustainable development, one can say that some of them offer a model too weak to help the students to understand the complexity of the subject. For example, playing with *Lachez-prise*[1] leads children to discover some "good habits" regarding environment protection but the game does not give any information about how these habits impact environment. Other games are more sophisticated but the model embedded in the game stays elementary. For instance, in *Ecoville*[2] it is expected that the player will build a "green city" but the social dimension of the question is mainly neglected. On the contrary, *Voyage au bout du charbon*[3], which allows the player to be immersed in the life of coal Chinese workers, focuses on these aspects and less on environmental issues. Thus, as a teacher or a student, it is essential to keep in mind that each game depends on the knowledge, values and decisions of the game designer and that the choices made impact both the player strategies and the knowledge that he/she is supposed to develop about the situation modelled by the game.

Furthermore, some games mix simulation and reality. By playing *Clim@ction*, an online multiplayer game designed for learning about land use management and sustainable development, secondary students collaborate to find better ways of producing energy. They have to learn why a specific strategy should be applied in a given "life-like" situation. Moreover, the game allows the player to ask questions to real experts by using the online platform and to carry out fieldwork using augmented reality. Mixing simulation and reality aims at maintaining the complexity of the subject to be learnt and, therefore, to design an authentic and complex learning situation.

Game-Based learning is based on a Piagetian point of view of learning and most games are based on a constructivist approach. In this paradigm, learning is considered to be an adaptive process, the learner/player incorporating the game experience into an already existing framework (*assimilation*), while reframing his/her mental representations to fit new experiences (*accomodation*). Game-Based Learning is also based on serendipity. Indeed, a game offers the opportunity to make fortunate discoveries while the learner/player is looking for something

[1] http://www.lachezprise.qc.ca
[2] http://www.ademe.fr/particuliers/jeu2/ADEME/ECOVILLE-2
[3] http://www.lemonde.fr/asie-pacifique/visuel/2008/11/17/voyage-au-bout-du-charbon_1118477_3216.html

unrelated by being engaged in an immersive experience where actions are driven by exploration. As a result, learning is situated (Lave, 1988) and allows for the bringing together of the elements of cognition (conceptual experience and knowledge), perception (perceptual knowledge and interactions) and action (factual knowledge and actions). Furthermore, playing a role leads the player/learner to strongly identify with his character. Thus, he/she benefits from an immersive experience within the game. At the same time the avatar is a "mirror to reflect on his or her own values and choices" (Jenkins, et al., 2006) and allows him to see " the virtual character as one's own project in the making " (Gee, 2003).

However, there is a difference between "trying to master the rules of the game and recognizing the ways those rules structure our perception of reality" (Jenkins, et al., 2006); in this way, contextualizing learning with games leads to a paradox. The learner/player becomes a puppet master. He/she is responsible about what happens as the results depend on his/her decisions and actions. A different decision could have lead to a different result. Therefore, one can wonder how one "can trust this game to tell us what happened when we are the puppet master? » (Egenfeldt-Nielsen, 2007). The puppet master paradox is probably one of the reasons why students are often reluctant to consider that they can learn by gaming (Ibid.).

In addition, Game-Based learning meets two main challenges. Game designers and teachers have succeed at preserving the entertainment aspects of the game. Some attempts to transform academic exercises into serious games have been named "sugar coating learning" (Egenfeldt-Nielsen, 2003) or "chocolate-covered broccoli approach" (Bruckman, 1999) to underline the failure of edutainment to keep the fun of gaming.

Another challenge faced by Game-Based Learning is to preserve the relevance of the content to be learnt. The balance between the serious side and the game side is difficult to attain. One way to solve this paradox is to consider that a game is a particular moment of a learning session and to fix the borders of the period devoted to play. This moment should be dedicated to experiencing an amusing gaming situation and to freely develop new strategies. Transforming the game experience into a learning experience implies leaving the game. By making the students strategies explicit through debriefing, by pointing out the knowledge embedded into the game, the teacher can help the students to be aware of both the new knowledge that they developed and the limits of the implicit information and values embedded into the game. Thus, learning occurs only after reflection and debriefing (Garris, Ahlers, & Driskell, 2002).

Games & motivation

The main point generally discussed in the Game-Based learning literature is the power of serious games to motivate students. Indeed, there is no doubt that games fit the expectations of most of students as they are widely used for entertainment. The power of games to foster motivation and involvement is described by the concept of "flow" (*ie.* the highest degree of motivation by "being completely involved in an activity for its own sake" (Csikszentmihalyi, 1990). However, distinctions should probably be made according gender. Boys and girls do not appreciate the same types of games. Furthermore, it is necessary to take into account that children are often reluctant to consider that gaming can foster learning. Game *vs* work, fun *vs* learning, freedom *vs* control... the paradox remains.

Self determination theory (Ryan & Deci, 2000) offers a framework to analyse the impact of serious games on motivation. According to Ryan & Deci (Ibid.), motivation results from different universal and innate needs and include the needs for competence, autonomy, and relatedness. The feeling of competence increases when students have to reach clear goals and get positive feedback. By playing a serious game, the learner/player takes decisions that are motivated by his/her consciousness of the situation rather than the teacher's expectations.

The game provides frequent feedback and it is usually possible to know what has been done and what is left to do. Moreover, usually, the level of difficulty can be adapted to the skill of the learner/player as the level of difficulty increase as he/she meets successes.

Autonomy entails the freedom to make choices, to take decisions and to choose a strategy. Autonomy results from the willingness of the learner/player to accept the challenge embedded into the game and to feel responsible for solving the problem, while remaining free to make decisions. This freedom is framed by the rules of the game, which are a set of norms and conventions that have to be respected. Thus, they both allow and limit freedom. Therefore, according to Vygotski, "in play the child is free. But this is an illusory freedom" (Vygotski, 1966). Being autonomous also means that the learner/player gets the opportunity to assess his/her strategy by her/himself and then decide if a taken decision or a given action is relevant or not. Assessing implies getting feedbacks and it is therefore clear that feedback is a crucial element in a game. Moreover, the need for relatedness entails competition. By playing *Clim@ction*, an online multiplayer serious game, students compete to submit proposals for the best project to implement sustainable energy solutions in their local environment. As they play the roles of energy company managers, they have to face the rivalry of others "companies" and they have to take into account the demands of "local administrators" and citizens. But competition is only one of the facets of the game and the capacity of students to propose a good project mainly results from their ability to collaborate. Students based in two different towns manage each energy company and they use a digital platform to communicate, share documents and information and design common documents. Connecting students in this way fits with their habits for being involved in online networks and can fulfil their need for interactions.

The power of games to motivate students also results from the fact that they allow for the consideration of the emotional dimension of the intersubjective experience of learning : humour, quality of graphical environment, social interactions, self-confidence and success. All these elements can enhance positive feelings and foster arousal. It has been claimed that the emotional dimension has an effect on the cognitive processes of attention, memory and decision-making (Damasio, 1996) and Game-Based learning offers the opportunity to take this into account. However, some educators are reluctant to introduce amusement into their teaching practice as there is a long tradition that opposes work to play.

Another aspect that supports the idea of serious games increasing motivation is that the learner/player can make mistakes and he is encouraged to continue trying (Gee, 2003). As actions or decisions do not impact the real world, play occurs in a safe space where the learner/player feels secure. As a "projective identity" (*Ibid*.) the avatar allows one to project one’s values and desires and endorses mistakes and failures.

On the other hand, the frivolity (Brougère, 2005) of a serious game is not always well established and the involvement of students can have unexpected consequences. As described in a previous article concerning a study about a pretend game about land use management (Sanchez & Jouneau-Sion, 2009), the students published their proposals online for the location of a railway loop designed to test a high speed train. Real citizens concerned by the location chosen by the students posted violent and tragic reactions on the website to protest. This example shows that the borders between the game world and reality are sometimes blurry; it is the responsibility of the teacher to make them clear.

Games as learning space

According to Brousseau (Brousseau, 1986) knowledge is fundamentally linked with problem-solving. Thus, knowledge can be considered as an instrument to deal with situations and knowledge emerges when a learner interacts with a *didactical mili*eu (*ie*. a learning environment). The concept of *didactical milieu* is crucial to Brousseau's work. It encompasses

all the elements of the situation that the learner has to deal with during his/her activity (both material and human). If the feedback provided by the *didactical milieu* is regular, the learner can anticipate and take into account the consequences of his/her actions. Brousseau's Didactical Situation Theory (DST) emphasized the crucial role of interactions. Therefore, a game can be considered to be a space of reflexivity where the learner/player can be autonomous. His/her autonomy results from the freedom to take initiatives provided by the game and the possibility to evaluate his/her taken decisions and chosen strategies according to the provided feedback. This feedback depends on the constraints of the model implemented into the game and on the rules of the game. Thus, the learner/player adapts his/her actions and learns how to behave according to the game constraints.

Game-Based learning is based on the implicit assertion that the skills developed during the game experience are transferable to real contexts. Indeed, the game world is designed to simulate a real context; by being immersed in an authentic situation and having to solve realistic problems, the players learns the "ways of acting, interacting, and interpreting that are necessary for participating" in the real situation (Shaffer, 2006). In addition, some games offer the opportunity for the learner/player to deal with complex situations and ill-structured problems (King & Kitchener, 1994). A complex situation is non-determinist. There is not a unique solution to an ill-structured problem but different solutions that have to be negotiated by taking into account both the available information and the identified lack of knowledge. To succeed, the learner needs to perform high level tasks according to Bloom taxonomy (Mayo, 2009). Moreover, the solution depends on a multidisciplinary approach and implies that the learner/player achieves complex tasks (Lasnier, 2000) activating both procedural, declarative and conditional knowledge to perform a set of actions adapted to the situation. Thus, it is expected that the learner will not only get new knowledge but also become able to identify his/her lack of knowledge. It is also expected that he/she will become able to "grasp subjects within their context, their complexity, their totality" (Morin, 2000). The ambition underlined by Morin is to educate XXIst century citizens for a more and more complex world and it has been advocated that serious games can provide the necessary innovative learning setting to reach such a goal.

Moving to the question of the type of knowledge developed by Game-Based learning and following Perry (Perry, 1970) an Belenky & al. (Belenky, Clinchy, Goldberger, & Tarule, 1986), who describes different stages (or *positions*) for cognitive development, we can formulate the hypothesis that serious games permit one to develop high *intellectual positions*. Indeed, according to Perry, a journey across the five different *intellectual positions* means two main transitions. The first transition is related to the acknowledgement of legitimate uncertainty in the world. The learner recognizes "not yet known" aspects of a problem and accepts uncertainty. The second transition consists in developing a vision of the world as essentially relativistic and context-bounded. The learner identifies himself as an active maker of meaning. However, a majority of traditional academic tasks focus mainly on finding the right answer to a closed question. Consequently, they develop a dualistic vision of knowledge such as "I know" or "I don't know". In opposition to this, solving open-ended and ill-structured problems by playing a game means exploring, accepting uncertainty, coping with diversity of solutions and making judgements.

As games offer the opportunity to design complex and situated learning situations, Game-Based learning fits with curricula based on a Competency-Based Approach to teaching. A competence is defined by three aspects : (1) it can be performed within a specific context, (2) it involves different types of knowledge and (3) it requires reflexivity about mobilization, integration and reorganization of these resources (Le Boterf, 1995; Tardif, 2006). As it has been stated above, serious games offer both a context to activate various types of knowledge to face a challenge and a space for reflexivity. Nevertheless, the opponents to this approach of learning formulate criticism that emphasizes the decline of disciplines and core knowledge, to be replaced by non-formal and mainly utilitarian competences. Indeed, an empirical research

about *Chronocoupe*, a serious game designed for geology learning, shows that the students who use the game mainly develop procedural knowledge (Sanchez, à paraître).

Developing declarative knowledge implies reflection and debriefing. This result emphasizes the importance of the teacher for helping the students to be aware of the implicit knowledge that they use in a specific situation in order to solve a specific problem. Game-Based learning emphasizes the crucial role played by the teacher in making the learning explicit and in helping students to decontextualize knowledge and make possible its transfer to other contexts. Similar results have been found by Habgood (Habgood, 2007) during his doctoral work related to a computer game used to teach mathematics to primary students.

CONCLUSION

These days, technologies allow us to design more and more realistic games, artifacts or situations, that offer the opportunity to implement authentic learning context in schools. It has been claimed that games fit the needs of XXIst century students in terms of methods of teaching and skills to develop. Besides, games are said to enhance motivation, to foster autonomy and to allow students to develop high-level competencies by being immersed in complex learning situations. However, establishing general conclusions and comparing studies becomes difficult as the term “serious game” is used to name different types of artifacts and different types of situations.

In addition, few empirical studies have been carried out to explore the power of serious games for the future of learning and the evidence for saying anything more than "games facilitate learning" is weak (Egenfeldt-Nielsen, 2006). The main arguments in favour of developing a Game-Based learning approach are still hypothesises that have yet to be demonstrated by empirical works.

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Biography

Eric Sanchez is professor at the faculty of education of the University of Sherbrooke, QC (Canada) and assistant professor at École Normale Supérieur de Lyon (France). His research work concerns the uses of Information and Communication Technology for educational purposes (elearning, simulation, serious games).