Development of Serious Games to Remedy the Problem of Innumeracy among Elementary School Students

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Abstract: *In this paper we discuss the problem of the Innumeracy among elementary school students, and how we can remedy this problem and solve the situation. We propose a method to motivate students to study mathematics especially mental calculation exploiting their video game culture using Serious Games. Serious Game is a computer application that combines a serious intention: pedagogical, informational, communicational, marketing, and ideological, or training, with fun springs from video games. To solve the problem of the Innumeracy we developed four Serious Games in flash and we can use them in windows platformer and online.*

Keywords: Serious game; video game; computer game; Innumeracy; motivation

1. Introduction

Mathematics is a difficult science; in primary school a majority of learners have a math learning difficulties. According to (Garnett, 1998), some of this problems are : Computational and arithmetic weakness, difficulty of memorizing basic number facts, computational and arithmetic weakness, weak understanding of concepts due to visual-spatial organization deficits; and confusion about terminology and the written symbolic notation system of math. In our class the problem of innumeracy increase among students.

So, to help learners to develop their math skills specially in mental calculation, and increase their self-efficacy beliefs (Meece, Eccles and Wingfield, 1990), the educator should try to incorporate teaching methods that emphasize the value of mathematics, This could be achieved through the use of computer application, because this applications promote active learning (Oblinger 2004) and the development of various skills (McFarlane, Sparrowhawk and Heald 2002), while they retain their entertainment and appealing qualities (Kafai,2001).

Nowadays, the practice of video games is a daily experience of young people. Rideout, Foerth and Roberts (Rideout et al., 2010) report that in 2009, 60% of youth aged 8 to 18 were playing video games daily compared to 52% in 2004 and 38% in 1999. According to this report, a young person between 8 and 18 years would spend an average of sixty-five minutes a day playing video games. Over the last decade, educational researchers have invested the relationship between video games and school learning through development, the implementation and evaluation of serious games integrating a digital world (Cruz - Cunha, 2012), (Allain andSzilas, 2012). Klopfer, Osterweil, and Salen (Klopfer et al., 2009) defined the game as "a voluntary activity structured by rules, with a definite result (win / lose) or quantifiable feedback (eg, points) that facilitates a reliable comparison of player performance "(p.11). By following this definition, serious games are games integrating a digital world whose purpose is the acquisition of knowledge in an academic field. These games can be integrated into a formal learning environment, informal or even practiced independently by an individual interested in acquiring knowledge in an identified field.

The problem of Innumeracy appears in our elementary school, because students are not motivated to learn arithmetic operations. To remedy this problem we will use the videogame competence of student.

We designed and developed the Serious Games that could be utilizes as an adaptable tool for the educational process. The purpose of the particular serious games would be to support the teaching of elementary school mathematics especially arithmetic calculation, as complementary learning tools that could enhance students' motivation and engagement with the subject.

So what is Innumeracy? How can we remedy this problem? What are the characteristics of our Serious Games?

2. What is Innumeracy?

Innumeracy, as defined by the General Committee on Terminology and Neology in France, is "the inability of a person to handle numbers and calculation in everyday life situations, even after receiving a teaching "(JORF, 2014). The corresponding capacity is called "digitism" by this same Commission or, more usually, "numeracy".

Since disability persists even after teaching, let us note from the outset that situations of innumeracy should also, or especially, concern adults. This is especially true since the notion of developmental dyscalculia (Fischer, 2009), which focuses on the specific difficulties of numeracy or mathematics, is more applicable to children and may interfere with the notion of innumeracy.

The children suffering from this situation are not able to manipulate the numbers, even on a daily basis. Orders of

magnitude, for example, are particularly affected. "If we ask a person suffering from Innumeracy how much is 8 cm + 7 cm, it can very well answer 45 cm or 23 cm, numbers that do not correspond to any reality", Make change, arrive on time at an appointment or calculate the proportions to make a cake then become an obstacle course.

The Innumeracy is not a disease, not even a disorder. «The students in this case are most often not of any particular pathology ", says the National Education in France. And the basis of Innumeracy is a problem of education, of learning. Some children will almost automatically use their hands to count when others do not. It will then be necessary to repeat several times to count on their hands, so that they visualize the figures. A math learning that is too abstract and based on the "by heart" could be in question. And this situation can be improved by learning.

In our primary schools, students who are in a situation of Innumeracy are not in a position to mobilize the basic notions of mathematics, calculus and the modes of reasoning.

So how we can remedy the problem of Innumeracy and how we can improve this situation?

3. Serious Games

According to the various studies that are already done in this area, the integration of the game in class is pedagogically interesting to manage behaviors or learning, to work history and geography (Virvou, Katsionis and Manos, 2005; Tuzun et al, 2008), the computer sciences (Papastergiou, 2008), to improve skills in mathematics and sciences (Klawe 1999; Annette et al, 2009), the health education (Dorman, 1997), or to progress in French and in arts. According to Ke (2009), who conducted a meta-analysis with 89 empirical studies on instructional gaming, the integration of the computer games in the classroom, can increase motivation and learning in a multitude of educational settings, both formal and informal.

So we can say that Serious games can offer a kind of meaningful learning context. It can be used for promoting the learners' learning interest and motivation, enhancing learning achievement and problem-solving skills.

In this context we have developed four Serious Games for students of elementary school to remedy the problem of the Innumeracy.

3.1 Types of serious games chosen

There are several types of video games on the market, such as fighting games, platform games, role-playing games, shooting games, sports games, puzzle games, strategy games ... This section therefore focuses on choosing the types of games preferred by elementary school students.

To choose the type of video games used in the development of our serious games, we did a survey of 160 grade six students. In this survey, seven play families are offered and each student indicates the type of play practiced. Figure1

shows the number of students for each type of game. Note that the racing game and platform game comes first.
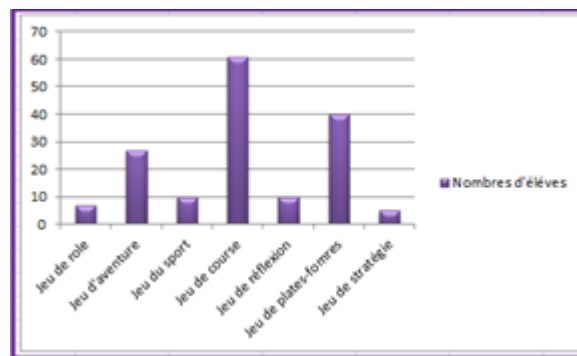

Figure 1: The number of students according to the type of game.

3.2 Play and Educate

According to our research on the Internet, there are no serious games of mental calculation in Arabic, and also in Morocco, we teach Mathematics in the elementary schools in Arabic, for this reasons we developed our games in Arabic. The goal of developing these games is to encourage students and to motivate them to train in mental arithmetic.

Serious games, in particular, contain the following three elements that make them so interesting, and can be used in order to motivate the learner: challenge, fantasy, and curiosity (Malone, 1980).

To remedy the problem of Innumeracy among elementary students and especially 6 Grade, we have developed four flash games that can be used on Windows platform.

We have also developed a Blogger in which we have categorized all the games that exist on the internet under five categories: addition games, subtraction games, multiplication games, division games and decimal numbers games. And we did the translation of the stages of each game in Arabic.
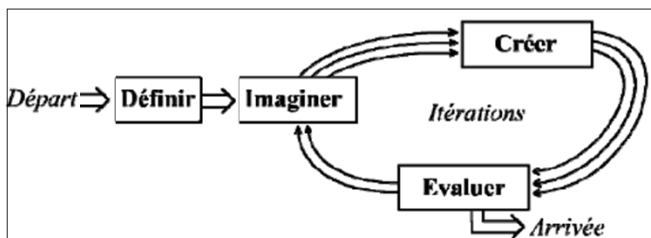
3.2.1 Our blogger

3.2.2 Designing and development of our Serious Games

According to different research in the design field of serious games, there is no universal method to design this type of game. So each designer can design their games according to their needs, and the target audience. In our work we used the DICE design method of Djouati.
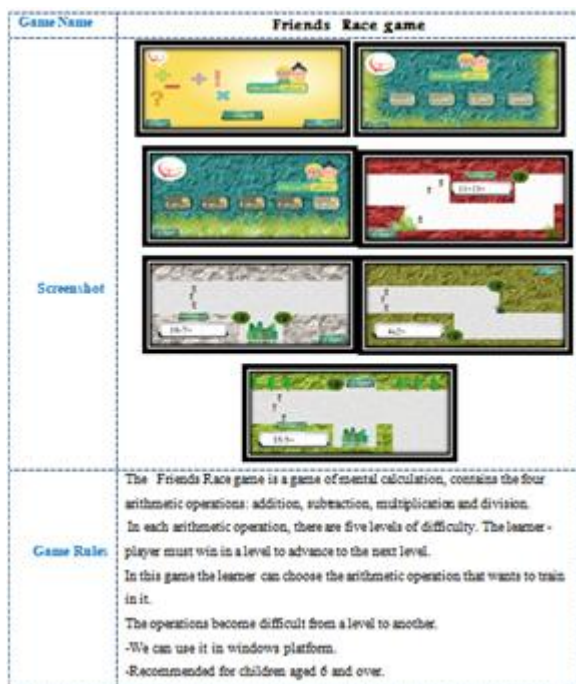

The design stages of our Serious Games are:

Define: In this step we have determined the educational objectives of serious Games. This is on the one hand to specify what we want learners to have acquired after playing the Serious Games On the other hand, it is a matter of building a repository of the field to teach. The latter, which can be represented in the form of a typed graph [Paquette et al., 2006] must contain the competences (knowledge, abilities, and attitudes).

Imagine: The second step is to invent the concept of play, contains both the story elements and the graphic and sound productions supporting the motivation of learners-players. And also the levels of difficulty, the method of progression in the game, and the conditions of use for the learner-player.

Create: In this step we have determined the development tools of serious games, and the programming languages.
Evaluate: After the development of prototype of serious games, we will test them with the learners in class.

Game Name	Friends Race game
Screenshot	
Game Rule:	The Friends Race game is a game of mental calculation, contains the four arithmetic operations: addition, subtraction, multiplication and division. In each arithmetic operation, there are five levels of difficulty. The learner-player must win in a level to advance to the next level. In this game the learner can choose the arithmetic operation that wants to train in it. The operations become difficult from a level to another. -We can use it in windows platform. -Recommended for children aged 6 and over.

4. Conclusion

Today's children spend a lot of time on playing video games, with their PlayStation, Xbox, or on mobile phones that neglect the outside world for the benefit of virtual worlds. They develop new skills, a new way of building their knowledge and solving problems that are very different from the traditional method used at school.

Several studies have suggested that this type of game has positive effects on problem solving, achievement as well as creating interest and commitment in learning (Tuzaun & et al., 2009; Kim, Park, & baek, 2009).

With the rapid growth of mobile phones, and portable game devices, the demand for useful applications of mobile device has increase. For this reason we will develop another Serious Game for student of elementary school to help them in mental calculation

References

[1] Rowe, J.P., Shores, L.R., Mott, B.W., Lester, J.C.: Integrating learning, problem solving, and engagement in narrative-centered learning environments. International Journal of Artificial Intelligence in Education 21(1-2), 115–133 (2011)

[2] A. Yessad, J. M. Labat, and F. Kermorvant, "SeGAE: A serious game authoring environment," Proc. - 10th iEEE into Conj Adv. Learn.Techno/. lCALT 2010, pp. 538-540,2010

[3] F. Bellotti, B. Kapralos, K. Lee, and P. Moreno-Ger, "User assessment in serious games and technology enhanced learning.," Adv. Human-Computer interact., vol. 2013, pp. 2-4, 2013.

[4] M. Papastergiou, "Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation." Comput. Educ .• vol. 52, no. I. pp. 1-12, 2009.

[5] J. M. Randel, B. A. Morris, C. D. Wetzel, and B. V. Whitehill, "The Effectiveness of Games for Educational Purposes: A Review of Recent Research." Simu/. Gaming. vol. 23, no. 3, pp. 261-276. 1992.

[6] Quelennec, K., Vermeulen, M., Narce, C., Baillon, F. : De l'industrialisation à l'innovation pédagogique avec une chaîne éditoriale. In : TICE 2010 (2010)

[7] M. Prensky, "Digital game-based learning," Comput. Entertain., vol. I. no. I, p. 21, 2003.

[8] Marfisi-Schottman, I. : Méthodologie, modèles et outils pour la conception de Learning Games. Ph.D. thesis (2012)

[9] Geary, D. C. (1993). Mathematical disabilities: Cognitive, neuropsychological, and genetic components. Psychological Bulletin, 114, 345–362.

[10] Francis, Chris. 2014. The important of Gameplay Balance.WWW-doucument. http://www.theoryofgaming.com/importance-gameplay-balance/.

[11] Akcaoglu, M. 2014. Learning problem-solving through making games at the game design and learning summer program. Educational Technology Research and Development, 62(5), 583-600.

[12] Hwang, G. J. and Chen, C. H. 2017. Influences of an inquiry Base d ubiquitous gaming deign on students' learning achievements, motivation, behavioral patterns, and tendency towards critical thinking and problem solving. British Journal of Educational Technology, 48(4), 950-971.

[13] Richard Van Eck and Jack Dempsey. 2002. The effect of competetion and contextualized advisement on the transfer of mathematics skills a computer-based instructional simulation game. Educational Technology Research and Development, 50(3), 23–41.

[14] Erhel, S. and Jamet, E. 2013. Digital game-based learning: impact of instructions and feedback on motivation and learning effectiveness. Computers & Education, 67(2013), 156-167.

[15] All, E. P. N. Castellar, and van Looy, J. 2015. Towards a conceptual framework for assessing the effectiveness of digital game-based learning. Computers & Education, 88(2015), 29-37.