

## INNOVATIVE ENHANCED LEARNING SYSTEMS: CONCEPTS AND CHALLENGES

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### ABSTRACT

The last decades, Internet has brought a revolution in the way people are acquiring knowledge. The emergence of new information and communication technologies (ICT) and social software networking is paving an innovative way on how teaching and learning can take place. New Innovative enhanced learning systems, based on multimedia content and strong interactivity are becoming more and more popular. These systems are based on computer visions, Artificial Intelligence, image processing. This paper presents two enhanced learning systems developed in Norway and Portugal. They are based on the concepts of game based learning and augmented realities techniques. The paper discusses as well the challenges in adopting such new ICT tools looking forward enhanced learning.

### INTRODUCTION

Today, it is recognized the educational landscape has evolved from a traditional teaching environment to a highly open and dynamic knowledge-based environment. The emergence of new technologies, new media contents and the large adoption of personal computers, smart mobile devices has contributed to create new type of learning requirements. These requirements include for example, the need to access in interactive way to multimedia contents anytime, anywhere. Furthermore, nowadays people expect to learn in motivating environment or to acquire new knowledge in an enjoying manner. Recent research works have demonstrated that people tend to learn more easily when they are entertained and are engaged in the creativity process involving thinking and emotion (Carlson, 2003; Gee, 2003). For instance, the work done by Blunt concludes, the application of serious games significantly increases learning (Blunt, 2009). One reason that is often invoked is closely related to the concept of constructivist learning. In constructivism, the learner actively constructs knowledge and learning by integrating new information and experiences into what they have previously understood. The learner by building cognitive structure combine propositional Knowledge often referred as fact, concepts

and procedural knowledge usually related to the techniques, skills and abilities (Lee & Lee, 2004).

In addition, it has been demonstrated that knowledge construction is best effective when taken place in social context, and in a setting in which new knowledge and skills are being used. Usually, people learn best through interaction with others (Young, 2003).

Furthermore, visual and spatial knowledge can contribute to a better assimilation by the learners. Indeed, people learn through viewing, reading, hearing and speaking, smelling, tasting, touching. In other words, the learning process takes place when people are experiencing and are linking their intellectual activities with emotions.

Lately, these issues have raised debates on how educational learning systems could cope with these new requirements. The use of Information and Communication Tools (ICT), Computer vision, augmented realities, and games could provide a mean to fulfill these issues.

Obviously the use of new technologies is contributing to shape the way of how and where teaching and learning is taking place (Breiter, 2004). Following the trend, several researchers have initiated development of new enhanced learning systems taking into account some of the requirements listed above by implementing for example game based learning or using augmented realities concepts in order to foster the learning process.

This paper presents two different innovative learning systems based on these concepts. The section two outlines a game based learning systems dedicated to people suffering from dyslexia butt willing to take a driving license test. The section three presents a new Multimedia Interactive Book (miBook) providing a responsive environment. miBook provides an interactive learning environment which handles different types of multimedia content.

Based on the both systems, the section four discusses the challenges, the benefits and drawbacks of using new technologies in order to foster the learning processes.

### GAME BASED LEARNING SYSTEM

#### Overview

Compared to the traditional computer based learning, computer game involves the learner actively in the

learning environment. They are several factors in favor of using these new interactive multimedia approaches to educational practices or to foster knowledge learning (Shih, Shih, & Chen, 2006). One of them is the recognition that play, constitutes an important part of human cognitive and social development. Gee reported in his study of video games as a learning tool that students are more likely to assimilate content by engaging themselves in a process of discovery (Gee, 2003).

In addition, people tend to construct knowledge in a best way when they are engaged personally; therefore computer game for learning purpose should involve content-based scenario or purpose. Furthermore, active participation in tasks is seen as a requirement for an active learning process; in fact, it is crucial to not separate the acquired knowledge from its everyday usage.

It is important to be aware as stated by Schnotz (Schnotz, 2002), that cognitive processing is not the only factor contributing to effective learning, but affective impacts and motivational should be taken into account as well. Moreover, if educational game are more engaging and appealing to learners interacting actively with these learning environment, it is worth to investigate further the use of these new game based learning approaches (Bourgonjon, Valcke, Soetaert, & Schellens).

Therefore, games board could be considered as an educational environment that is rich in opportunities as they satisfy the people competitive urges and the wish to master new skills and concepts (Robertson & Howells, 2008). Today, it is well recognized that board games for example are a very good means to encourage every player (learner) to take individual responsibilities, practices real-life simulated tasks and experience the outcomes of any decision making (Shih, et al., 2006).

### **Test driving computer Game**

In order to validate the concept, we have developed a game based learning dedicated for dyslexic people. Dyslexic people usually experience difficulties with word or number recognition, poor spelling and thus their reading capability is reduced. In consequence, Dyslexic people have problems in acquiring further vocabulary and some specific knowledge. Their capability to process visual information is often affected; thus resulting in a slow reading tempo. In addition, dyslexic people experience problem with short-term memory, which limits their ability to remember or grasp the meaning of long sentences. For example, taking a driving license might represent a harsh task and a challenging process. For long time, dyslexics were considered as bad drivers as it could take them longer to develop automaticity in driving tasks. In addition, some of them were not able to talk with a passenger at the same time as driving. However, research done by Nicholson (Nicholson, 2008) suggests rather that with appropriate teaching methods, dyslexic learner can drive and pass their practical test with success. For

example, his research work highlights the need to use multi sensory learning and to ensure that new information or skills are heavily embedded. For example, if someone has poor visual memory, then they can use their auditory or tactile memory to compensate (British Association Dyslexia). Obviously, dyslexic people require lots of reinforcement to embed learning from the short term memory; fortunately most of them have excellent long term memories. So the learning process should focus on encouraging the long term memories and on the repeating phases in slower mood. Several initiatives based on recording an audio book in addition to the traditional driving book have emerged. In some case, this was enough to help dyslexic people to acquire the needed knowledge to pass the driving license. However, this approach seems to be not appropriate in some cases. Our research project aims to investigate how the use of a game can enhance the learning capability for people with dyslexia. Our current project is based on an existing project done in collaboration with the Norwegian Association for Dyslexia. A board game called "Traffik Panik" has been developed. This game is inspired from the "Trivial Pursuit", but the questions are extracted from a driving book. The game board is composed with a cardboard playing board, question cards, dices and small plastic cars to represent the players on the board. The figure 1 illustrates the game board.

This educational board game contributes to learn to drive safely and to educate people to the requirement of a driving test. The game board has a start space and several squares corresponding to different situations.

Based on this existing game, we have developed a computer game that allows one or several learners to play. A first prototype has been implemented with the goals to further engage the player (s) by being more interactive.

The figure 1 illustrates the game board. Each square on the game board is associated with a task the player has to conquer. From Marc Prensky's table "Types of Learning" the best way to communicate facts are either questions, association, memorization or repetition (Prensky). To comply with the table, the game will keep the original idea from the existing game, and every normal square will have a question task. The other squares on the game board will be associated with small sub games. Each sub game will extensively drill players on important facts.

Every time the player moves to a question square, a question dialog appears with a question suited for their level. The game is based on multiple choice answers. Each time the player gives the correct answer, the learner moves one step on the board toward the finish line. The interest of this game is the repeating aspect of the questions as it will help the player to learn through repetition. However, in order to keep the player engaged in the game, the questions are implemented in random way and therefore, starting new game will introduce each time a level of novelty in the questions. Each time, the

player gives a wrong answer; he will stay in his position on the game board until he gives the correct answer to a new question.

### **Game design and development**

Designing a serious game is challenging and need a structured process design. The first step aimed at gathering the users, technical requirements. Several scenarios have been developed in order to understand how the game can be played. The second phase focused on translating these requirements into functional specifications. A technical architecture encompassing various components has been delineated. The third phase focuses on selecting the right technologies in order to implement in best possible way the various defined functions. The phase 4 focuses on developing the prototype. A preliminary test and validation of the software game have been conducted.

We have developed a simple character creator, allowing new players to set up new character. This editor is not used to create avatars or other character appearance modifications. In this game, the character is used to connect vital information and achievements to a distinct player. This feature allows the sharing of one game installation among several users and will keep track of the achievement of every player (character). Achievements are stored and therefore, it is easier to keep record of the performance.

Amongst the user requirements, we focused on programming a user interface with a panel of colors that suits best dyslexic people. "Scotopic sensitivity syndrome" also known as "Irlen syndrome" is categorized as a form of dyslexia (Morgan, 2009). People suffering from Irlen Syndrom have extreme problems focusing or seeing the text clearly, this can also be due to the color contrasts used in the text. Therefore changing to another background color might help considerably. Text and background color can be configured in the character settings, so the player always will get his selected color set in every dialog, menu and text shown in the game.

Another requirement that has been implemented into the game is the audio feature. Since reading can be a frustrating activity, for each card, an audio file has been associated. Therefore, when needed, the player can just press a button and listen to the question instead of reading it

The developed game based learning prototype is still under development and therefore extensive assessment of the game need to be further conducted. However, Preliminary test has been conducted with the physical Board game and it showed promising results. The next step after implementing further functions is to validate further our computer game based learning by inviting focus group experiencing dyslexia to play.

## **AUGMENTED REALITY CONCEPTS**

### **Introduction**

Augmented Reality systems and technologies were introduced in 1992 by Caudel and Mizell when they were interested in optimizing a wire assembly procedure for the construction of the Boeing 747 (Caudell & Mizell, 1992). In general these systems provide the means for "intuitive information presentation, which enhances the perceiver's situational awareness and cognitive perception of the real world" (Behringer, 1998). This enhancement derives from the computer-generated information which is usually registered in 3D space and related to objects and places in the real world. Considering AR as a visualization and interaction technique, the relationship of real and virtual objects maybe focused and contextualized in two different aspects: In both cases, AR generates the final image by overriding parts of the real world imagery with synthetic images taken from 3D scenes (Kalkofen, Mendez, & Schmalstieg, 2009). Based on the augmented realities concepts, a we have developed a Multimedia Interactive Book (miBook<sup>1</sup>) as a new tool providing a responsive environment.

### **miBook concepts**

miBook is an interactive learning which handles with different types of content. It may represent a notable instrument for enhanced learning (for individual use or in the classroom) as well as it can represent a great step forward, regarding the enhancement of current digital libraries. Additionally, the integration of different interactive teaching materials will provide a better learning environment that will allow students to step forward in their learning experiences, both in the classroom as well as in their home place.

miBook is the combination of a printed book (or its digital format) with the respective audiobook and its story-related 3D models (as well as 2D graphics), using technologies, like Augmented Reality and Multimedia, as frameworks to present and interact with audio-visual content.

Technologically, miBook environment consists of a handheld camera, a personal computer (to generate user's individual AR views), and a physical book. miBooks uses "normal books" with text and pictures on each page and have an additional audio content – the correspondent audiobook.

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1 miBook® (registered mark) is a novel product/service developed since 2005 by SbH – Solutions by Heart, Ltd. in collaboration with GITICE, Research Center from Universidad de Huelva (Spain) and ADETTI from ISCTE IUL (Portugal). (<http://www.mibook.org>, 24/04/09). (<http://www.solutionsbyheart.com> 24/04/09)

miBook may represent the ideal and affordable solution for these natural transitional teaching-learning models by supporting traditional pedagogical approaches, such as reading books or viewing pre-recorded classes, as well as innovative pedagogical different approaches by providing rich media (automatically generated audiobooks and/or 3D virtual interpretations of educational context), during reading, watching or listening. miBook focused on the improvement of the interactive learning experience, by exploring optimal combinations of educational materials (traditional and digital), learning methodologies and capabilities of common devices.

Visual images are produced by means of computer graphics techniques, from 2D or 3D scene objects, generating, respectively, 2D or 3D graphical images. Computer graphics requires a digital computer with graphical computing capabilities, enough memory to store a representation of a scene made of objects, a frame buffer to store the synthesized graphical image, a display screen, input devices and modalities (2D or 3D mice, keyboard, gesture, speech, tangible interfaces, etc), and specialized software that enables the computer to take pictures with a virtual camera, producing photo-realistic images. In figure 2, we depict an image (photographic capture) of interacting with miBook contents with 2D graphics (left) and 3D graphics (right). Only 3D allows for an enriched interaction and visualization of the scene, including a perception of depth, by means of virtual navigation and examination including the possibility to translate, rotate the virtual camera and the objects.

### **CHALLENGES AND OPPORTUNITIES OF NEW TECHNOLOGIES IN ENHANCED LEARNIG**

Recent educational trend is based on constructivism that emphasizes that knowledge is constructed by the knower based on mental activity and seeking experiential meaning. Computer games, multimedia content or augmented realities tend to increase the efficiency of the learning capability. Therefore, technology could play an important role in the learning process. It may represent a notable instrument for enhanced learning (for individual use or in the classroom) as well as it can represent a great step forward, regarding the enhancement of current digital libraries. Additionally, the integration of different interactive teaching materials will provide a better learning environment that will allow students to step forward in their learning experiences, both in the classroom as well as in their home place.

Already for example, applications such as the EyePet from Sony, allow the integration of 3D graphics on the TV screen into real world settings. Computer simulation using graphically displayed images may facilitate comprehension of educational contents by permitting simulation of phenomena in a real context environment **EyePet (2010)**.

In conclusion, there are clear benefits of using technologies in order to provide innovative enhanced learning system. The table 1 provides brief overviews of such opportunities. However, in same time there are important challenges to overcome before we could consider that using technologies provide only positive effects on the learning enhancement.

### **CONCLUSION**

Recent research studies have demonstrated the positive role of using games. In this paper we present a prototype of a test driving computer game board. The paper discusses the potential of helping dyslexic people in learning the driving rules by providing a new way to acquire new knowledge. The project is still under development therefore a large scale evaluation is not yet done. However, the preliminary results and basic test lead us to believe that using game board can contribute to foster learning capability for dyslexic people.

In addition, in this paper, we presented the concept of miBook based on augmented reality concepts and multimedia. miBook is combines the feature of a book, its respective audio book and story-related 2D or 3D models. miBook allows interaction with audio-visual content.

Considering nowadays technology state-of-art, there is strong potential to further develop new innovative enhanced learning involving more deeply in an interactive way the learner in the learning process. However, there are still many challenges to overcome such as consequent cost, lack of adequate training, teaching designers, learning materials and reluctance from the educational systems to adopt easily new learning systems.

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Figures and Tables

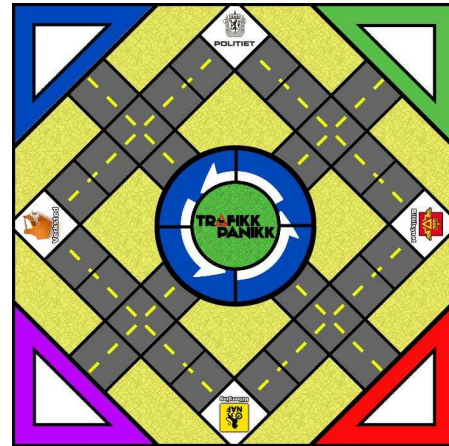


Fig. 1 Traffik Panic” Game Board

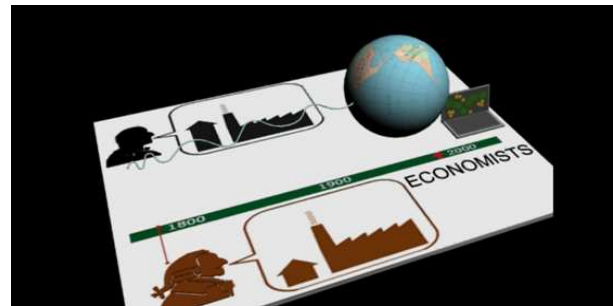


Fig. 2 miBook contents example - “International Conference on Economics”. Demonstration in SIMO IFEMA-Madrid, Spain 2007. Copyright (2007) SbH – Solutions by Heart, Ltd.

Table 1 Benefits and drawback of Innovative learning systems

Benefits	Drawbacks
motivation and engagement of the learners	Risk of addiction thus staying too long of computer might lead to physical pains such as neck aches, ect...
Secure and contextual environment	Risk of Low self esteem due to the concept of win /lose usually implemented in a game
Experiment in a safe virtual world thus enhancing the knowledge acquisition	Digital Content not appropriate for the learning purpose
Learned centered	Social isolation
Integrate various skills such as visual, cognitive, communication ect. and	Difficulties to design learning material requirement

enhance them	development of specific skills
Different level of knowledge	Gender specific –The game are usually more appealing for boys .. this is due to the nature of game
Self assessment and self control of the learning progress	Need to define clearly the learning goals--Difficult to measure the progress
Independence	No clear learning objectives
Cost might be reduced	Need sophisticated equipments such as video, devices, ...
Reduce learning anxiety by providing an open and friendly environment	Too much flexibility might result in loss of control