
ON THE TEACHING AND DEVELOPMENT OF GAMES AND VIRTUAL REALITY EDUCATIONAL SYSTEMS

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Abstract: Rapid development of informatics technology caused appearance of jobs that didn't exist ten years before, a new situation on the employment market, which influences also introducing a new concepts in teaching and education, e-learning and virtual reality systems. This paper is focused on research and development of the new, virtual reality based systems in an academic environment in Serbia. A few years ago started course in computer game development and interactive media at Metropolitan University in Belgrade. The courses centred on real time interactive 3D computer graphics include also artificial intelligence and mathematical modelling. This constitutes the base which enables the teaching of techniques of creation of realistic 3D virtual environment populated with intelligent characters. The obtained results are illustrated by en examples of the student projects.

Keywords: E-Learning, educational systems, gamification of learning, virtual reality, serious games, artificial intelligence,

1. INTRODUCTION

Education process based on teaching and learning tools designed to enhance a student's learning experience by including computers and the internet in the learning process is very attractive both for research and application [1]. Virtual reality (VR) systems as mediums of interactive computer simulations that sense participants actions and providing feedback to one or more senses, are very attractive for various fields of applications since they give feeling of being immersed in synthetic world. The student can in a safe way learn how to control an airplane, to drive car in a distant town or in adverse weather conditions, or make surgical operations [5].

High-level technology usually applied in VR gives sophisticated systems and high fidelity replicas of real systems; however, high price often limited area of application. On the other hand, rapidly developing computer game industry developed a class of games with very realistic game worlds, often offering an illusion of reality comparable to those in high-tech VR systems, but with much lower price. These low-cost VR systems, namely those exploited in the computer game technology are very promising to be applied in schools.

However, there is a belief that it was not happening fast enough or in enough depth to prepare students for the future [6]. Namely, there is an increased interest among young population in South-East Europe for new media, virtual reality and game based technologies. In spite of

lack of official university programmes, young people from the region often participate into various student competitions, frequently with significant success (for example, Imagine Cup). As a result, various educational courses were open, among them computer game design course at BMU (Belgrade Metropolitan University), and the promising experiences are reported in [11].

The paper is organized as follows: Next section discusses origin and role of artificial environments used in the education as well as it's computerised versions. Section 3 presents teaching of design and development of computer game course and VR systems at BMU. Several student projects, described in section 4, illustrate teaching results and relative success.

2. VR IN EDUCATION

Learning by reading is one of unavoidable methods in all schools. On the other hand, acc to Dale's cone of experience [2] learner retain twice more information of what they HEAR, five times more of what they SEE and HEAR, and nine times of what they DO.

Naturally, a long time before Dale published his cone of experience, schools used teachers to tell and explain the students learning content. The teachers also exploited various educational accessories and models to show and explain what is to be learned. Finally, since the most effective way of learning is by doing, a student is put into improvised "real" environment (a kind of laboratory and/or equipment) and asked to perform the task or

activity, which is a learning objective.

The advent of computers and specially PCs and computer graphics enabled computer assisted illusion of reality called virtual reality (VR), which is exploited everywhere - from engineering and production, to everyday life, art and entertainment. Usually virtual reality is primarily experienced through two of the five senses: sight and sound, but may also include touch feel. The simplest form of virtual reality is a 3-D image that can be explored interactively at a computer, usually by manipulating keys or the mouse so that the content of the image moves in some direction or zooms in or out. More sophisticated VR involve wrap-around display screens, actual rooms augmented with wearable computers, and haptic devices that let you feel the display images.

Virtual reality is exploited in simulator technology (extensively used in military and civilian training), as well as in computer games and film industry



Fig 1. Example of "low cost" flight simulator

While this technology is considered high-tech and very expensive (so called full flight simulator may cost over 20 million dollars, while Alsim AL50 [7] of only 50000 euros represent low cost device), very close is a class of serious games applications [4,8] (often known as "light weight simulators") which uses not expensive components (basically computer game technology) which makes them available for various activities. The serious games are used in a pedagogical way for political, social, economical, humanitarian and other purposes [4].

In the education (other than those based on expansive VR training systems and simulators) VR is used to create illusion of real environments, and by virtual simulations allow students to do things in environments they might not otherwise have access to. Specially, educational games (which are serious games used in education) add a components of attractively, tighter interaction with virtual world and added fun to learning. Namely,

- student is active in exploring virtual game world
- student is exposed to challenge to progress through game levels
- educational game offers a fun during learning

- artificial instructor, properly designed, may help the student, be more patient than human being and less prone to human imperfections.

While simulations and serious games have been used to varying degrees in schools, there is a belief that it was not happening fast enough or in enough depth to prepare students for the future [6].

Note

Some authors [1,3] use slightly different concept of VR introduced here, known as virtual learning environment (VLE), based on simple using of computers in education process. For example, ref [3] defines: "A *virtual learning environment (VLE)* is a set of teaching and learning tools designed to enhance a student's learning experience by including computers and the Internet in the learning process. The virtual environment is housed online and is accessed via the Internet."

Thus, VLE may be text-based ones, often not including VR, especially not sophisticated 3D virtual reality technology.

3. TEACHING OF COMPUTER GAMES AND VIRTUAL REALITY

The techniques for development of computer games and VR applications take part of study at various universities worldwide. As an example, refs. [9-12] give some details how this is done at Aalborg University, Denmark, where Problem Based Learning (PBL) approach is applied.

At BMU (Belgrade Metropolitan University) is applied classical teaching concept, established in 2005 at Faculty of Information Technology (FIT) at a bachelor level [11]. Based on this concept FIT pioneered in Serbia introducing e-learning and enabling study to students not able to attend classes in a traditional way. Recently, this study line was completed by master and PhD education levels, and successfully applied to other fields introducing faculty of management, faculty of digital arts and faculty of tourism and sport.

Also, few years ago (2009) a module for Computer Games was introduced with the aim to fill in the gap (there were no similar education in the country). Module covers the following areas:

- Game design
- Computer graphics
- Artificial intelligence
- Game physics
- Programming 2D and 3D games
- Educational games

The last area is introduced in order to give more space to serious games and application of VR to various fields of human activity. The students are prepared to apply software game technology to solve the tasks that are not (only) entertainment.

In addition, Problem Based Learning (PBL) and Gamification approaches are combined with classical

teaching concept et BMU in order to improve effectiveness of the study. More details on PBL reader may find in ref [11], and gamification approach and it's implementation at BMU is described below.

3.1 Gamification of learning

Gamification is the use of game-like thinking and elements in places that aren't traditionally games. The use of game mechanics and dynamics like badges, leaderboards, and actions can be useful for improving motivation and learning in informal and formal settings. Gamification attempts to harness the motivational power of games and apply it to real-world problems – such as, in our case, the motivational problems of schools [18]. Motivation and engagement are major challenges for the American educational system, and, (to our belief) also in Serbia.

Gamification is relatively new in education and present wide area of possibilities. Due to it's complexity as a system it requires rather innovative ways of lecturing, especially when it comes to the e-learning, classification of tasks to be performed and their range.

During the course "Introduction to computer game" students, learning how to create games using GameMaker and Unity 3D., had several options of accomplishing it but the most successful one was creating games themselves. Levels of creation were divided into three groups thus all of them had chance to advance from introduction, through medium and up to high level.

Using GameMaker and Unity 3D environments, students passed from learning GameMaker and Unity 3D interface, through studying development process and psychology of video games up to creation of playable 3D games. This is, in fact, a gamification of learning, simply because students are supported to learn to create games by playing the big game: "How to make real, valuable computer game".

This play is performed during the lessons (in fact exercise part) and the students were assisted by instructors. To help students it was allowed to use resources provided during lecturies for their own projects. Results were astonishing: instead of simply moving content around and changing it a bit some students actually improved idea and the content dramatically. For example, one of student used game resources available from the lessons to create his own environment, sets, rules, and graphics as seen on the figure bellow.

This work reflects on already introduced techniques of teaching game development to both programming and design-oriented students, innovations and upgrades of already existing schemes.

4. EXAMPLES OF EDUCATIONAL AND SERIOUS GAMES

Related concept to gamification is serious games, which in fact are "the games used not only for entertainment". More or less, the role of serious games in practice reduces

to (some kind) of education and makes them very close to educational games. Several serious games were developed during activity at BMU (see [19]), some examples are presented below.



Fig 2a. resources from the lesson



Fig 2b. Student results

4.1. Serious Game DriveON

DriveON is a serious game built for Imagine Cup student competition [11]. It is a low-cost virtual simulation environment for learning of car driving (fig 3). It is based on DIS (Distributed Interactive Simulation) concept i.e. the software implemented on the several personal computers c communicating over network (LAN).



Fig 3 DriveOn is Serious Game – Low cost simulator

Student and instructor interface is represented by physical driver controls and visual system and virtual instruments

(fig 4). The main part is car dynamic model, designed to sufficiently well represent all relevant static and dynamic characteristics of real vehicle. In the DriveON the model represents OPEL Corsa 1.0, which is used for test and model tuning and validation. The traffic is represented by a number of computer driven vehicles (i.e. by virtual intelligent drivers), which respect the traffic rules.



Fig 4. Driver controls – low cost game interface – serial product

DriveON has implemented different scenarios where student may be trained in different situations like city traffic, open road or country side, high way, dry, wet, snow or iced surface. By using Instructor Station, the traffic condition may be changed, like control of every single car, (tell them to go on next cross-road left or right turn), also weather condition; traffic light signalisation may be changed. Instructor station has its own driving tests, for faster and better education of students.

The data about teaching are easily collected and may be used for further analysis to improve teaching or to adapt to particular student. In total up to 5 computers with specific input/output devices, connected over LAN, are used to implement DriveON simulation environment. Three computers are used for visual system with attached projectors. One computer is used for both traffic simulation and car dynamic computation and one is used for Instructor Station module. Unlike to the traditional training, DriveON offers safe training in risky situations as well as in adverse weather conditions, It may be easily adapted to other types of vehicles, extended by driving-learning assistance system or virtual (artificially intelligent) instructor.

4.3 Solar system - educational game

Educational content of the game is knowledge about solar system and basic facts about its exploration.

The gameplay is inspired by extraterrestrial conflict which (might) happened at Nuremberg in the year 1561. The player, participating in the conflict visits planets at to succeed in a game, should demonstrate a knowledge about planets. During a fight, player learns the facts from

educational content and solves the test questions at the end of the play.

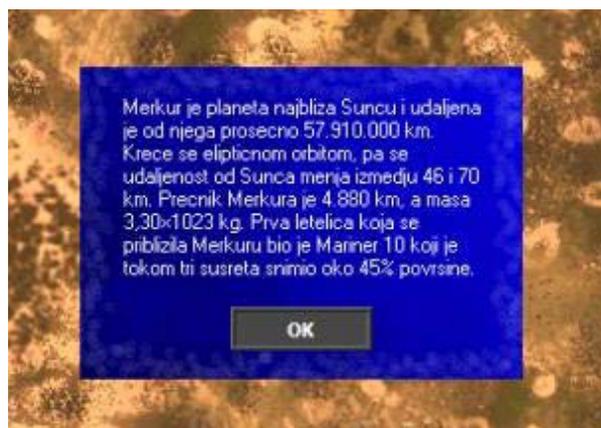


Fig 5. Example of educational content from Solar System

Educational part of the game is implemented both in the English and Serbian languages (example of screen is shown in fig 6).

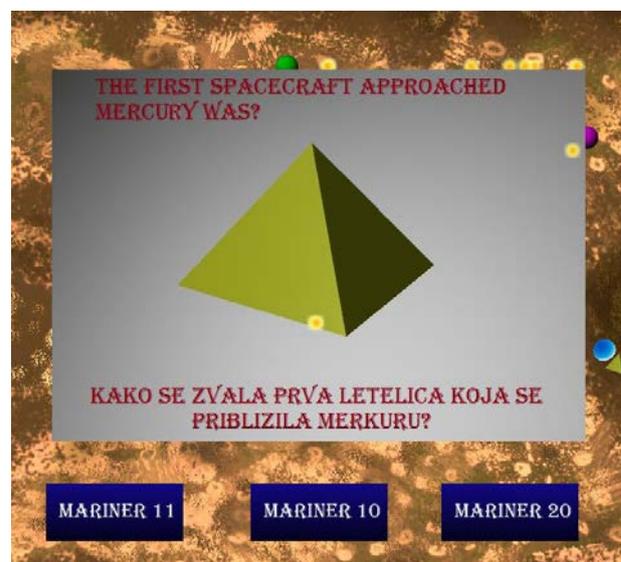


Fig 6. Test question in the game

4.2 Geography 5

This is a student project at BMU [15] with an aim to make more interesting study of geography in the 5th year of elementary school. Using keyboard and mouse schoolboy may easily navigate and progress through the lesson, thanks to well-designed visual interface.

To progress through game, pupil should answer the test questions by clicking to a right option or make association by drag&drop technique or give textual answer using keyboard. Total score indicates success of the pupil learning.

The game is based on 2D graphics, implemented in Adobe Flash, so it can be opened in web browser and accessed by internet.

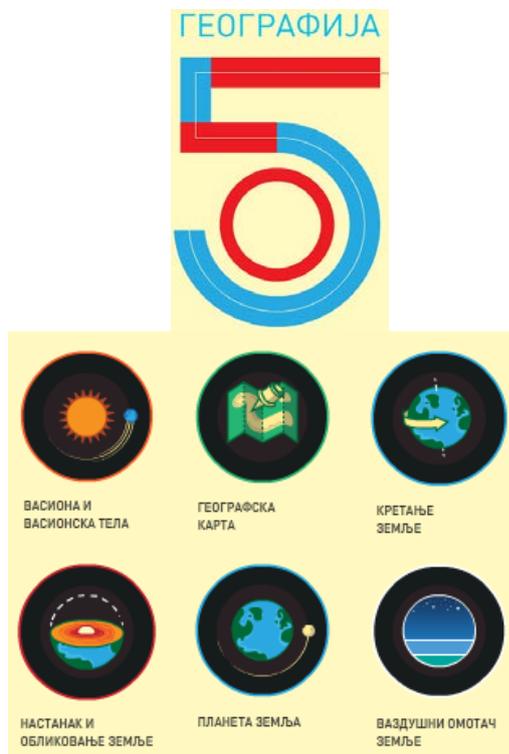


Fig. 7. Screen-shot from Geography 5

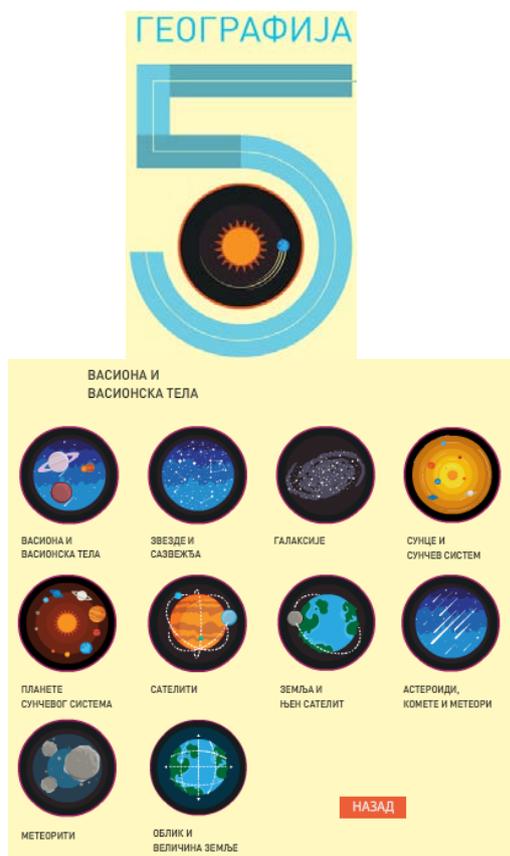


Fig. 8. Screen-shot from Geography 5

5.CONCLUSION

Virtual reality systems offer favourable possibilities for education since they give feeling of being immersed in synthetic world, enabling a student a safe way to learn, even in adverse weather conditions and independent of geographic location or historic period.

The computer game technology and specially class of serious games offers low-cost VR systems which may be applied in schools with low budget.

An increased interest among young population in South-East Europe for new media, virtual reality and game based technologies resulted in several serious games and virtual reality applications, competitive at international level.

New university course in computer game development, opened at Belgrade Metropolitan University, in a few years give good results, promising to further enhance this process. Part of this success is due to applying untraditional concepts of Gamification and Problem Based Learning in teaching the students how to create modern computer games.

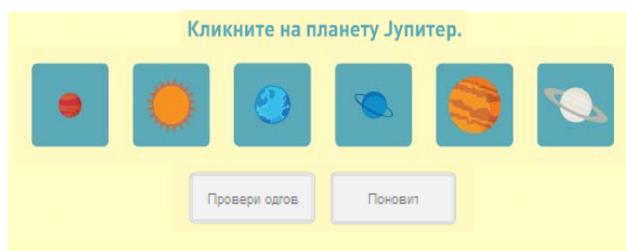


Fig 9. Test question from Geography 5

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