ENJOYABLE EDUCATION?

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ABSTRACT

Recent studies show that interactive education is of highest interest. In the 21st century schools and universities try to avoid standard ways of learning, changing them to more entertaining ones. In this paper I describe the potential role of video games in making the education less boring and more effective, together with the studies investigating this topic thoroughly. Lots of examples are discussed, concerning applying interactive way of education at schools and requirements for creating serious games. Finally, I share my reflections after playing one of such games myself.

INTRODUCTION

The world needs well educated people, that not only got their degree, but also have gained knowledge, skills and experience. Unfortunately the academic education is not so appealing.

The studies done few years ago [2] showed that half of the engineering students have resigned. It happened not because of lack in their abilities (they had the same results as those who stayed), but because of poor teaching methods. What is even more interesting - as a reason of, so called, "poor teaching" - they gave not the quality of a lecturer, but rather the lecture itself. As a student, I must also admit, that standard lectures are usually hard to follow and not so effective. To get involved, students need at least some kind of "interactive engagement".

As a solution to that problem, we should consider the idea of serious games. These are video games that serve a particular purpose - they can be used for training, education, health issues, etc. They are designed and created according to concrete requirements and are much more than only entertaining.

One could ask: why games? The answer is very simple. Nowadays games have begun to surpass television viewing [1]. Young people spend enormous numbers of hours inside games. It means, that probably they would also be willing to spend more time on studying, if it was enjoyable. The same technology that makes interactive games so entertaining, can be used as well for education and training, making it more effective! It's the highest time to create a science of games - not only design serious games, but also educate students in this field, so they are able to develop it in the future.

POTENTIAL ROLE TO CURE

In the last years the interest in computer science started to decrease significantly. There are less students willing to start engineering studies, and even if they do so, they do not have motivation to learn, consult textbooks, do exercises and reflect on the material [9]. There is a growing need to find any solution to that problem. Video games should be considered as a such.

The observations of the lecturers [9] show that young people nowadays are:

- highly visually oriented and much more willing to learn by trying out and watching than reading textbooks,
- able to use computers already at early age, and
- less interested in science.

These observations indicate that video games can be, indeed, a cure for poor education. Merrilea J. Mayo defines in her paper [2] five reasons supporting this assumption.

MASSIVE REACH. As mentioned earlier, playing games surpass even television viewing. The numbers speak for themselves: a typical immersive game on the Internet involves over 250.000 active subscribers, more popular ones can attract even few millions [2]!

The stereotype is that games are appealing only to male-dominated group, but some

studies show, that they attract women as well. It depends on the kind of a game - obviously shooter or racing ones will be much more popular among boys, while some, like for example the Sims, have attracted a female demographic in the 60%-80% range [2]. It means that we can still reach both genders with game-education - as a proof I will later discuss a case of a storytelling game.

What is very important - games can be used in a classroom, but not necessarily. They give the ability to reach students where they live, what increases the time students will spend on learning and makes education more appealing.

EFFECTIVE LEARNING PARADIGMS. Video games support some of the learning paradigms [2]:

-Experiential learning - "*If you do it, you learn it*" - this is the most used mode of instruction in games; you need to make decisions while you play;

- Inquiry- based learning - "*What happens when I do this?*" - to achieve the goal, you need to explore, discover and experiment while playing;

- Self-efficacy - "*If you believe you can do it, you'll try longer/harder, and you'll succeed more often than you would otherwise*" - the players are encouraged to play more if they get points, go to the next levels and see their progress;

- Goal setting - "*You learn more if you are working toward a well-defined goal*" - every game has a goal;

- Cooperation - studies show that working in groups gives better results - this is very common in massive multiplayer online games;

- Continuous feedback and tailored instruction - they can be found in almost all video games.

ENHANCED BRAIN CHEMISTRY. Till now I have mentioned only general ideas and findings, but there are also more scientific studies indicating, that video games can help with learning. In 1998 they found, that playing games stimulates dopamine release - players can reach even twice the normal amount [2]. Dopamine is a chemical precursor to the memory storage event, which means that while playing games, we prepare our brain to gain knowledge.

TIME ON TASK. The average student spends five to eight hours per week on homework and the average gamer plays almost 7 hours a week [2]. If we could combine these two fields, it would mean that we can even double the amount of hours spent on studying. What's more - students would learn more willingly, so more effectively.

LEARNING OUTCOMES DATA. The studies show that, in general, students learn more if they have any kind of entertainment. I present results from few of such studies in the next chapter of this paper.

STUDIES INVESTIGATING THE EFFECTS OF INTERACTIVITY ON LEARNING

In the previous chapter I discussed a potential role of video games in making the education more entertaining and effective. There have been several studies done investigating the effects of interactivity on science learning among students and the results showed that, indeed, video games would be kind of a solution.

One of the studies was done in 2002, when two first year classes diverged in their assignments sets [7]. One of them was a game-based and the other a standard one. After measuring the results and comparing them (using special metrics), it occurred that game-based assignments were showing a significant advantage over the others. They were more complex and required more effort, but still, the students were quite willing to follow them. Also in the successive courses students from the game-based group got better grades (18% improvement).

As an alternative to a game-playing course, there are also game-design courses. One of such was given by Brianno Coller [2]. The students were asked to program virtual cars and a race track, using their knowledge. The other, non-game-based group, consulted textbooks and made exercises. At the end of the year they drew a concept map of what they had learned. It showed that the game design exercises didn't change the breadth of the content learned during the course, but they significantly increased the depth and complexity of what was learned. Also the students were more pleased overall with this course than with others, spending time on their work voluntarily.

Without any doubts we can already say that any kind of entertainment will make the education more effective. The question is if it's very important to have also the interactivity factor? Few years ago there was a comparative

study done, that investigated the effects of interactivity and media richness on science learning among college students [8]. The experiment included four groups, from which one (I) was playing a game, the second (II) watched replays, the third (III) used a hypertext version of the game including the narrative context and screenshots from the game and the last one (IV) had only standard text fragments. Thus, they were divided within the interactivity factor (I and II), as well as media richness factor (comparing I to III and II to IV). The results were interesting. Although participants' baseline knowledge levels for all four conditions did not show a significant difference, the first three resulted in increased knowledge and topic interest, and were able to sustain these effects over time. The fourth one (text) remained rather unaffected. It means, that interactivity might be indeed not so crucial in media based learning. However, still, the new media in general are superior to traditional education.

EXAMPLES OF USING SERIOUS GAMES IN EDUCATION

Although not on a large scale yet, video games are already present in education. A perfect example can be a professional master's degree program opened in 1999 by Carnegie Mellon University and preparing students for video game and digital entertainment industries [4]. Students learn how to work in interdisciplinary teams, where some of them are more interested in computer science and some in arts. The curriculum is different than in case of any other studies - it is project-based with almost no lectures. There are only four compulsory courses in the first semester (and they are all highly connected with games and entertainment technology) and in the next three semesters students work on their projects - interactive games and simulations. Teams are required to build an artifact, often a prototype, but also a finished product sometimes. Some teams have an external sponsor or client, so instead of pretending that projects matter, the faculty makes them matter. Students tackle real projects and learn to interact with groups. After 2 years they are undoubtedly prepared for work in entertainment technology industry.

Such master's degree program is intended for students, who are interested in computer science. However, serious games can be used also in other situations. At the University of Twente they are developing the new BsC curriculum Creative Technology and decided to adopt a more constructive approach to teaching. A new course was introduced in which students learn "the heart of mathematics" by means of an adventure game called Mr. E's knapsack [9]. It's a game that combines the attractiveness of a fantasy world with education. Players have to actively use some mathematical items that they've picked up in order to solve problems at later stages of the game. Such an approach to learning math is for sure new, but very promising.

As I mentioned before, it is very important for computer science to attract female demographic as well. It occurs that games can be a solution to that. If you ask middle school girls how many of them want to learn to program, you won't see to many hands going up. But if you ask how many of them want to learn to make animated movies like those from Pixar and Dreamworks, you will get a very positive response [5]. That's why a serious game Storytelling Alice was successfully introduced to middle school girls. It is based on an existing programming environment Alice 2.0, that allows novice programmers to create interactive 3D virtual worlds. To construct a program users drag and drop code elements, so there is no possibility of making syntax errors. Using Alice, they learn basic concepts of programming, like loops, conditionals, methods, parameters, variables, arrays and recursion. Covering all these topics takes usually several weeks. While the study participants didn't become experts in two hours, they did make progress. They were motivated to program and expressed interest in taking a future Alice course.

Caitlin Kelleher and Randy Pausch find in their article [5] three reasons why does Storytelling Alice really work:

- It gives girls an opportunity for self-expression,
- It gives girls an opportunity to think through issues they encounter in their own lives, and
- It allows girls to share stories with friends and classmates.

This experiment clearly shows, that serious games have the potential to attract students that are not yet interested in computer science and diverse in gender.

HOW TO BUILD SERIOUS GAMES?

Designing a video game is one thing, but doing it in the way, that it will serve educational purposes is something completely different. We need to find a trade-off between entertaining and educational parts, so how learning can be conveyed through games without diminishing content.

Such an approach is taken in one of games developed by researchers at the Integrated Media Systems Center (IMSC) [8]. *Metalloman* is a serious game that teaches physiology concepts to undergraduate college students. Players are presented with experiences from which they can extract information, what seems to be more engaging for them. The researchers used the *Entertainment-Education* paradigm, which says that all forms of play are learning and all forms of learning are play and that the separation of learning and play is artificially imposed [8]. There is an underlying assumption, that a relationship between entertainment and education exists and that its optimal state requires a *sweet spot*. A sweet spot is a state when the elements responsible for enjoyment function sufficiently enough to motivate for information processing and don't distract students from valuable knowledge content.

In video games we find both visuals and sounds that contribute to entertainment and may contribute to learning as well. It happens either directly (by allocating attention to educational content) or indirectly, when increased enjoyment motivates for learning.

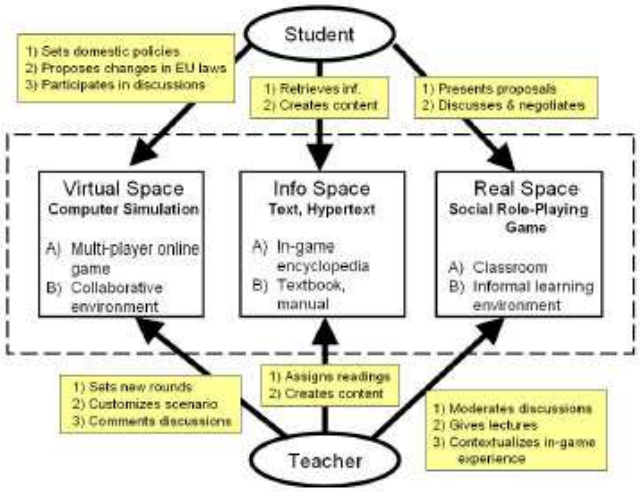

FIG.1

When designing a serious game we have to remember, that except entertainment factor, we need to provide students with sufficient information. But how to present such educational issues? Often serious games cause a frustration because of a conflict between the game play and the teaching material, e.g. interaction when learning is interrupting the flow of the game play and disturbing the player's immersion. Also the playing part and the learning part often don't form a unit, what is essential for a serious game. To solve these problems, games could be designed according to a methodological framework for augmented learning environments (ALE) [6]. Conceptually, ALE combines few different platforms in which the game takes place, e.g. the real space, the virtual space and the information space. Between them there are defined causal links, which assure that actions of students in one space transcend to the others [Fig.1, *Europe2045* game as an example of using ALE]. Such links have to be created already by a game designer. It creates one inherently-consistent learning environment.

In general, when creating curricula based on games, educators need to be sure, that the games they choose will be as engaging as the typical commercial entertainment games, but still conveying valid educational content to the player and able to motivate students of both genders.

Immune Attack

Immune Attack is a single-player video game combining a realistic 3D depiction of biological structure and function with educational technologies for teaching immunology to high school students and college freshmen [3]. It consists of few levels, each of them more challenging. In the first one the player learns how to train the most basic immune cell, the macrophage and how to recognize friends and foes. Using built-in hints he navigates a blood vessel in order to find the infection and kill the bacteria. In the next levels the invaders become more sophisticated in their method of attack, what requires that players train highly specialized immune cells. The main idea of *Immune Attack* is that the players explore 3D world gathering all important information and when they think they know enough, they switch to small 2D games, where they attempt to train the cells. If players fail, they are given hints with regard to what information is missing.

FIG.2

To make the game effective (players usually skip introductory text) it is designed to let players gather information through clear visual and auditory media that provides information while allowing their eyes to stay fixed on the action. *Immune Attack* includes a tool called *My Learning Assistant* (*MyLA*) [Fig.2], which can be accessed at any point of the game - players pause the game and can ask questions.

During a series of alpha tests, students found the game accessible comparing to traditional textbooks. Clever visual tools and clear English explanations did make this extremely complex biological system lucid to all players.

Global Conflicts: Palestine

Global Conflicts: Palestine [10] is a game that places the players in the middle of the Israeli-Palestinian conflict. They take on the role as a newly arrived journalist, who is drawn more and more into the events of the area, get to know more people and their stories. The players gain experience as a reporter and might help shape the way things are being reported from the region. They are able to make friends and enemies while talking to people. During the game players should take notes from the interviews. They have always few options of how the conversation can go like. Depending on that, they can get more or less information from the inhabitants and soldiers. When enough information is gathered, they start to write their article, that is based on the quotes they have noted.

After playing this game myself (you can download a free demo version from *www.seriousgames.dk*), I must admit that it is really well designed. Although I'm much more interested in computer science and technologies than in social science, I have immersed myself in the game in few moments. It is surprisingly complex and the main window is a 3D world with quite nice graphics as for a serious game [Fig.3]. However, the designers haven't focused only on the visual side. *Global Conflicts: Palestine* is

FIG.3

meant to be a serious game and so it is! While playing, you get to know about different aspects of living in a place, where is a war. After only two hours of playing, I have already gained some knowledge about the conflict. It is easily accessible and entertaining. I would probably never spend two hours just on reading articles about the conflict and even if I did, I wouldn't remember too much of it. Playing a serious game occurred to be really effective. After submitting my article (so finishing the first level) I got very promising feedback:
"*Your article on the consequences of the establishments of checkpoints and the impact they have on the lives of civilians and soldiers alike is very popular with the editors of Global News. They give the article a prominent placing in the newspaper and the story sparks new interest in the whole debate about the barrier. (...) You receive a number of fan letters from people who are very happy with your work."*
Getting such a feedback encourages to playing the next levels of the game (which I haven't done as there is only one level in the demo version). It can even act as a starting point for learning more about the conflict. However, the game might be at least as engaging also for the people who have already some knowledge about the situation - it can act as a new and different journey into a conflict they know all too well.

CONCLUSIONS

Courses and curricula related to computer games and video game programming and design have attracted widespread attention recently not without a reason. They occur to be a solution for boring and not effective education. Although many institutions still view games as academically marginal, it seems that games might finally appear in everyday education. It is true that a game programming course doesn't teach a significant new set of skills that cannot be taught in a traditional way, but apparently this approach motivates the students much more, so they spend a lot of time working willingly on their assignments. After my positive experiences (while playing a serious game or attending courses at my university, that were taught in a more interactive and entertaining way), I must agree that serious games could be a future of education. Now it depends only on the educators to make this future not so distant.

REFERENCES

1) *"Creating a science of games"*, Michael Zyda.
2) *"Games for science and engineering education"*, Merrilea J. Mayo.
3) *"How to build serious games"*, Henry Kelly, Kay Howell, Eitan Glinert, Loring Holding, Chris Swain, Adam Burrowbridge and Michelle Roper.
4) *"Combining the left and right brain"*, Randy Pausch and Don Marinelli.
5) *"Using storytelling to motivate programming"*, Caitlin Kelleher and Randy Pausch.
6) *"Towards a Novel Paradigm for Educational Games: The Augmented Learning Environment of 'Europe 2045'"*, Vit Sisler, Cyril Brom and Radovan Slavik.
7) "*Serious games + computer science = Serious CS*", Katrin Becker and J. R. Parker.
8) "*Serious Video Game Effectiveness*", Wee Ling Wong, Cuihua Shen, Luciano Nocera, Eduardo Carriazo, Fei Tang, Shiyamvar Bugga, Harishkumar Narayanan, Hua Wang and Ute Ritterfeld.
9) "*Math game(s) - an alternative (approach) to teaching math?"* Anton Eliens and Zsofia Ruttkay.
10) "Global Conflicts: Palestine - User Manual"

APPENDIX

Annotated bibliography:

1) *"Creating a science of games", Michael Zyda* - an introductory text to next five articles.

2) *"Games for science and engineering education", Merrilea J. Mayo* - the author is interested in video games as a potential cure for poor educational system. She looks into the learning literature on games and scientific studies of learning outcomes from games.

3) *"How to build serious games", Henry Kelly, Kay Howell, Eitan Glinert, Loring Holding, Chris Swain, Adam Burrowbridge and Michelle Roper* - an article about creating a game designed to teach immunology to high school students and college freshmen.

4) *"Combining the left and right brain", Randy Pausch and Don Marinelli* - describes 2-year game-development master's degree program.

5) *"Using storytelling to motivate programming", Caitlin Kelleher and Randy Pausch* - the authors discuss how to motivate children's and girls' interest in computer science through storytelling and game technologies. They describe the process of creating "Alice" - a game that allows novice programmers to create interactive 3D virtual worlds - and testing it among students.

6) *"Towards a Novel Paradigm for Educational Games: The Augmented Learning Environment of 'Europe 2045'", Vit Sisler, Cyril Brom and Radovan Slavik* - an article describing features of ALE (Augmented Learning Environment) through the educational game paradigm, Europe 2045. It discusses requirements for educational games, as well as possible limitations.

7) *"Serious games + computer science = Serious CS", Katrin Becker and J. R. Parker* - an article about applying serious games in academic education. It describes a game programming course, where students were divided into 2 groups (game-based and standard). The authors discuss also a course, where computer science students worked together with arts students.

8) *"Serious Video Game Effectiveness", Wee Ling Wong, Cuihua Shen, Luciano Nocera, Eduardo Carriazo, Fei Tang, Shiyamvar Bugga, Harishkumar Narayanan, Hua Wang and Ute Ritterfeld* - an article about a comparative study that thoroughly investigates the effects of interactivity and media richness on science learning among college students. It discusses important results and implications yielded from comparisons among four conditions from the experiment: game, replay, hypertext and text.

9) *"Math game(s) - an alternative (approach) to teaching math?" Anton Eliens and Zsofia Ruttkay* - an article presenting an alternative, interactive way for teaching mathematics; the authors discuss how computer graphics can be used for creating math games, together with an example of such adventure game.

10) "*GLOBAL CONFLICTS: Palestine - User Manual*" - user manual for the game I have tested.