LOOK ACADEMIC PUBLISHERS
OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
2016, VOL. 11, NO. 16, 9255-9265

Educational Game Systems in Artificial Intelligence Course

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ABSTRACT

Article actuality based on fact that existing knowledge system aimed at future professional life of students: a skillful use game activity in educational process will teach students to look for alternative ways solving of real problems. The purpose of article lies in theoretical substantiation, development and testing of criteria, which must be met by special-purpose software oriented on gamification of educational process. A leading research method of the described problem is a method of simulation that allows to consider gamification as concentration and organized process for increasing the factor of student engagement in cognitive activity. This article aimed to demonstrate models of ideal educational game programs with optimum number of gamification elements, also article focused on development of such software, which will be not entertaining, but educational in nature. The article may be useful for researchers dealing with gamification issues and software developers, which works relate with educational programs.

KEYWORDS
Education, game design, gamification, interactive education, social interaction

ARTICLE HISTORY
Received 27 May 2016
Revised 17 July 2016
Accepted 19 August 2016

Introduction

Computer and video games have influenced western culture for more than 35 years. Starting with classic games like Trek, Pong and Space Invaders, which started a tide of Cultural Revolution. Notably in 1981, with Nintendo's masterpiece, Donkey Kong, and not only the introduction of the titular character, but the protagonists, Mario and Link, who would become main Nintendo's character for many years. Other examples include Pokémon, which continues to be popular children's toy, also popular culture icons, every kid who grew up in the nineties has at least heard of them. But over that 35-year span, approximately eight generations of video games have been created. It sprang

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from consoles and PC games, MMO and VR-projects. This gives a setup to a new culture embraced the whole world.

It is important to realize that computer games are not just a form of entertainment, especially if we talk about educational games. These games allow a player to acquire new knowledge and skills (Galimova & Shvetsova, 2016; Valeeva & Amirova, 2016).

Many modern video games have clear, meaningful goals, multiple goal structures, scoring system, adjustable difficulty levels, random element of surprise, and an appealing fantasy metaphor, all things a good education system should have. An example of all of these qualities was provided in the form of simulation games that require one to form their own world, such as the Civilization series, and the Tycoon series. Other ways video games provide education, allowing manipulation of otherwise unalterable variables, seeing phenomena in new perspectives, and observing actions over time.

For example, the site of Museum Of Science And Industry (Chicago) allows visitors to play in game Code Fred: Survival mode. This game was designed for teen players, and focused on study of major body systems and processes that occur in the human body in extreme situations. In game user not only overcome many obstacles, but also examines structure of human body. In addition teens learn to use a computer mouse and the stylus, as well as learning to compose simple programs for survival search bot.

The most important part of any game is study of levels and external world. In quests player finds a items, combines them and uses at key points to advance through main story. In strategy games player collects and converts resources in order to expand control scope and reach a victory over enemy. In puzzle game user solves problem using not only game instruments, but also using own knowledge and skills. Finally, in role-playing games user is engaged in characters management who have to survive and acquire new knowledge in a hostile environment. In all these cases, a detailed study of surrounding space requires care, patience, expertise and logical thinking from player.

Player who started new game can take a role, which he cannot play in real life. As part of gaming simulation player can become car driver or airplane pilot. Players who prefer narrative games like Deus Ex, can become special agents or adventurers. The storyline of these projects depends not only from game writers and character abilities, but also from moral and ethical decisions taken by player during adventure.

Games allow simulating different situations possible in real life. Player's errors can cause a full-scale disaster, but it is a rewarding experience. Lessons learned from virtual errors that can be used to prevent problems in real-life situations. Most efficiently this technique works in transport simulators (car, aircrafts, ships, submarines) and strategic games which simulate operation of complex social and political systems.

It's safe to assume that the role of computer games in society will increase from year to year. In medium term, games will be not only entertainment but also a learning tool and their elements will be to meet inside specialized and educational software.

Basic principles of gamification was described by J.J.Lee & J. Hammer (2011). We also found that gamification techniques was used for specific applied

courses like music education (Denis & Jouvelot, 2013; Glazyrina, 2013; Valeeva, Korolyeva & Sakhapova, 2016) and industrial design (Koster, 2004). Deep examination showed that while gamification techniques are adopted to support classroom learning of content in specific subject areas, they are also employed to pursue transversal objectives, such as digital game learning (Prensky, 2003) and AI learning (Malone, 1980; Kirillov, Vinichenko, Melnichuk & Vinogradova, 2016; Sadchikov & Suslova, 2011, 2014; Suslova & Sadchikov, 2015), making assessment procedures easier and more effective (Moccozet et al., 2013; Lomovtseva, Chubarkova & Karasik, 2013; Boronenko & Fedotova, 2015; 2016), integration of exploratory approaches to learning (Gordillo et al., 2013; Neupokoeva & Chapaev, 2016), and strengthening student creativity (Barata et al., 2013; Encyclopedia of creativity, 1999).

Materials and Methods

Research methods

At research, following methods were used: theoretical (philosophical, psychological, technical and pedagogical literature analysis; generalization of domestic and foreign experience of creating computer games; empirical (pedagogical observation, testing, ranking, and pupil activity analysis, diagnostics of understanding levels, statistical processing of research results and their academic interpretation); methods of mathematical statistics and graphical display of results.

Experimental base of the research

The pilot survey was conducted at basis of Russian State Vocational Pedagogical University. Experimental research work basis made by authors as teachers of computer disciplines in university IT courses.

Research phases

The study included three stages.

In first stage (theoretical search) was conducted a theoretical study of the problem of cognitive activity, emotional content and socialization of the learning process of students on the basis of analysis of philosophical, psychological, pedagogical and methodical literature, which helped to formulate the original position of the study and to define its conceptual framework. Researchers was identified didactic potential of computer games.

In second stage (experimental research) was implemented methods of teaching students using elements of gamification and revealed didactic potential of computer games.

In third stage (synthesis) was made analysis, generalization, systematization, and final processing of experimental work results.

Results

Gamification is a methodic tool, which involvements students into educational process focused on increase of many educational factors by means additional entertaining elements. In a broader sense teacher uses gamification and game mechanics relates with it, for increase of involvement of pupils into educational process for increasing of learning efficiency. In J.J. Lee & J.

Hammer (2011) "Gamification in education: What, how, why bother?" article shows that Gamification has impact on three elements of basic educational process: informative activity, emotional filling and pupil socialization.

Informative activity is the general element of educational process and games. In many games, cognitive activity connected with research of surrounding space (levels, locations), accumulation of knowledge and use of received information for goals achievement. In games, informative activity has limited character because many goals player can be achieved by repeated attempts without deep studying of game mechanics. However, there are games the victory in which is impossible, without full understanding of virtual reality. Dark Souls (From Software) is a good example of such game. The player is in obviously unprofitable conditions here, and his victory depends on that, how well he studied surrounding space and understood rules by which game environment works. If during training process wrong conclusions were drawn, game won't allow the user to reach new levels, because player have not knowledge and abilities (both theoretical, and practical) for achievement of the final purpose.

Cognitive activity is a active state of the individual, which is characterized by a individual desire for learning, mental stress and the manifestation of volitional efforts in the process of acquiring knowledge, can to significantly improve the effectiveness of the training (Suslova, 2008).

A selection of pedagogical conditions for developing a technology using the task simulation games have been studied by many researchers. In particular, the system of tasks on development of pedagogical skills through the game was described in works T.V. Nadolinskaya (2013), J.S. Ezrokh (2014), M.V. Fominykh, B.A. Uskova, V.V. Mantulenko, O.N. Kuzmina & E.N. Shuravina (2016).

In many cases, games allow player to achieve the same objectives in various ways. Search of possible ways depends on player's ability to collect process and analyze received information. Very often games reward user who managed to achieve a goal in the non-standard way by additional experience or empower character's abilities.

Gamification of informative activity in educational process will allow solving a goal-setting problem. Students who managed to collect information in gamification process will immediately receive educational award after reaching the purpose. In additives to it, skillful use of informative activity in gamification process will teach students to look for alternative solutions of real objectives.

Emotional involvement. Like other entertainments, games give to users a wide range of emotions among which is both pleasure and disappointment. The emotion caused by perfect action have various influence on specific player. Some players feel feeling of pleasure, having reached a victory whereas victory reached without overcoming of difficulties does not inspire others, and disappoints them.

Disappointment and feeling of game property loss, as a rule, force player anew passes levels and raises project replayability. During repeated passing player receive feedback from the program and gain new skills necessary for achievement of a victory. Thereby he increases own skill level and starts understanding an objective perspective more deeply. This property can be successfully used for improvement quality of gamification of educational process.

Social interaction. Gamification elements allow pupil to try new social roles and look at educational process from other, earlier unknown point of view. The player in a safe environment can master the new role. In case of need pupil can replace it with another one that suits him better from educational point of view. Game social interaction is especially important in educational courses connect with project management. Students can test owns skills in many roles which will allow them to see distinctions in the used techniques and practical approaches.

Social interaction has extrovert style. Students, which achieved certain success in training, can show own achievements to other in the form of "awards" or "trophies" that stimulates emulative spirit in collective. In case of successful introduction, similar mechanics can focus students on profound studying in a game form. Social interaction can stimulate joint activity of students, by means of "awards" which are given, both for joint solution of tasks, and for cooperative overcoming of game obstacles.

Methods of social interaction are most effective in case of use network technologies meaning data exchange between students. Information exchange of trophies and knowledge can organized, both in the program, and beyond its limits inside web-forums or special sections of social networks.

For creation of educational game project, we chose a Unity Engine. This technology was well documented and our programmers were familiar with it solution.

Before programming the game, we wrote a design document, and planned basic steps of creating the educational system (Figure 1).

The first version of game project made in 2D basis. The game environment represented in classical scroller style reminds Dangerous Dave in Hunted Mansion (Edge Software). Game character move inside university building, jump, and also interact with various objects. Level backgrounds, heroes and objects were drawn as sprites because it simple and easy-to-use solution. Project algorithmic base includes search, movement and object behavior algorithms. Network games interaction based on record table and on-line competitions system.

Students read theoretical material and finished test receives a network key, which can be used once for receiving access to special game level. At this level, besides obstacles, locates parts of additional theory which unlocks confidential locations at early game levels. In opened secret locations character must answer on questions created by in-game NPC. This questions based on theoretical information gathered player inside game levels. In case of successful solution player receives a level-up for heroes characteristics and earns trophy which shows inside user's profile.

It is important that at any moment of time each student could compare own trophies to trophies of other pupils and estimate own achievements within the game and educational environment.

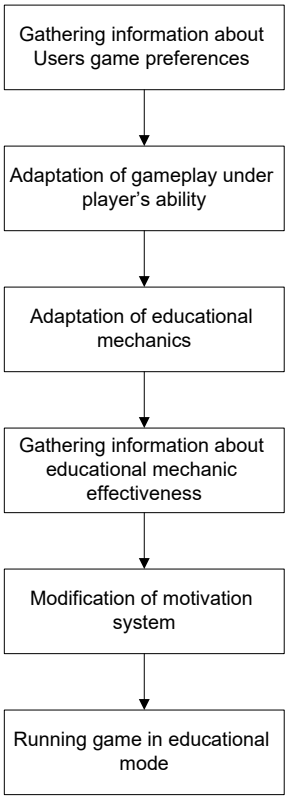

Figure 1. Adaptation of gameplay and motivation mode within game educational system.

Moving ahead on subjects, student gets access to new levels of game, and his heroes open secret points at earlier passable levels. In case of full passing of game student can receive new difficulty levels (active from game restart) and get access to more difficult blocks of theoretical material, and also to new trophies.

Emotional involvement in game based on slowly increasing of difficulty levels. Game is able to correct level complexity if player can't overcome some game obstacle. Thus pleasure from game could receive players with various levels of reaction and knowledge. Game program traces further activity of players and raises complexity level, when those receive new experience. Finishing game at high difficulty level stimulates by best prizes, additional secret points, and also trophies inaccessible at the easy level.

Information about educational and game sessions gathered by game designers at early stage of game. The subsequent analysis of data allowed optimizes a project gameplay, by means of correction game and program mistakes.

The test group RSVPU actively used educational game system during studying of "Artifical Intelligence" discipline (Figure 2). The result of quality improvement shows in Table 1.

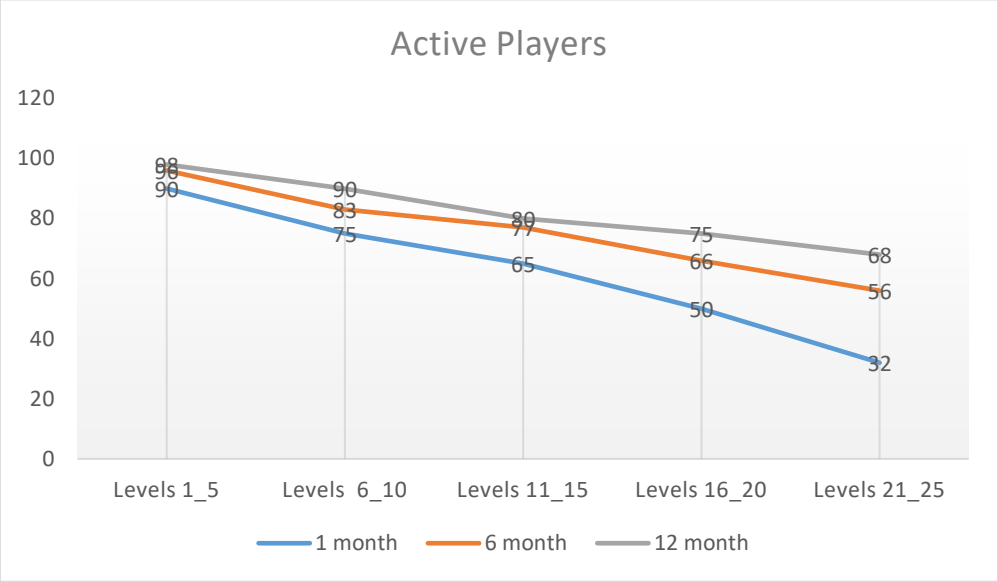

Figure 2. The change of game DAU (Day Active Users) over the life of educational game project.

Table 1. Improvement quality of educational process with usage of gamification program.

Educationalgroup	Checkpoint 1 (GPA)	Checkpoint 2 (GPA)	Checkpoint 3 (GPA)	Final Test (GPA)
Test Group	4,12	4,22	4,34	4,41
Group 1 (standarteducation tools)	3,92	4,01	3,84	4,05
Group 2 (standarteducation tools)	3,75	3,95	3,47	3,98
Group 3 (standarteducation tools)	4,01	3,72	4,05	4

Gamification of educational process means use one or several previously mentioned elements during performance of educational tasks. The number of elements used in same time is not limited. The more game elements it applied during training, the more pupils perceive educational process, as game.

If during educational process it is applied from 1 to 2 game elements, pupils perceive educational process, as the educational system possessing game elements. If quantity of game elements more than 4, in this case pupils assume that, program has entirely entertaining project.

Gamification of educational process requires special software. For creation of similar program, it is necessary to define those criteria to which it will respond. The below-provided list of criteria created by results of creation of the educational and game software on base of the Russian State Vocational Pedagogical University:

– The understanding of target audience – Target audience of learning game software is a student form different departments. If game process of a learning software connected to the theory, users can pass some game elements. If theoretical material is identical to all groups, changes in a software can happen at motivation.

– Determination of educational targets – Users shall achieve educational objectives in end of the game. Educational targets can be various for different groups of pupils. Game process will change with modify of educational targets.

– Determination of system of motivation – Developers select motivational system, proceeding from technical features of game, and preferences of target group.

– Determination of gamification activities – Developers design it before programmers begin write program. In case of need, additional types of activity added in game prototype.

The greatest issue is effective creation of the social unit. Educational game system must be oriented on creation of effective end self-sustaining community.

After definition of basic criteria, programmers must define type of technology used in project. In certain cases educational game system can be create with unique technology. Now, many projects created on basis of freely extended game engines such as Unity 5 and Unreal 4 (Table 2). With it help is possible to create, both two-dimensional game programs, and more difficult projects executed in 3D worlds. Unity 5 and Unreal 4 developers allow use full versions of these software products in educational purposes, without additional financial investment (naturally, academic versions of this engines have a number of restrictions in comparison with commercial analogs).

Table 2. Comparison Unity 5 and Unreal 4 game engines.

	Unity 5	UnrealEngine 4
ProgrammingLanguage	C#	C++
3d support	Yes	Yes
2d support	Yes	No
FreeVersion	Yes	Yes
ProVersion	Yes	Yes
PC Support	Yes	Yes
PlaystationSupport	Yes	Yes
XBOX Support	Yes	Yes
NintendoSupport	Yes	No
IOS Support	Yes	Yes
AndroidSupport	Yes	Yes
HTML 5 Support	No	Limited

Discussions

Active development gamification methods began in first decade of the 21st century, when gaming technology has reached a level of development sufficient for use in educational processes and business processes. Gamification principles used in many disciplines: mathematics, the study of foreign languages, teaching

programming, as well as in logistics and in different types of art. For example, gamification technology was used in the gardening (Watson, Hancock & Mandryk, 2013).

Gamification techniques are adopted to support classroom learning of content in specific subject areas, they are also employed to pursue transversal objectives (Karimova, Makhankova, Troinikova & Suvorova, 2016; Sturikova, Albrekht, Kondyurina, Rozhneva, Sankova & Morozova, 2016), such as fostering participatory approaches (Li et al., 2013), self-learning (Watson, Hancock & Mandryk, 2013), completion of homework assignments (Goehle, 2013), making assessment procedures easier (Moccozet et al., 2013).

In contrast to the works of other researchers, our work involves the creation of a software game product, teaching artificial intelligence playfully. Using gamifications software as a learning tool, students can learn complex theoretical material, and also to see in practice how AI theory is applied in computer games. We were able to gather information about the pinnacle point where educational system becomes a game and vice versa. The collected information can used for balance game systems with numerous elements of gamification.

Conclusion

In case of a successful gamification of a training course, educational process gets the following advantages:

- students perceiving educational process, as game property which can be improved and which has direct value;
- opportunity to make and correct errors, taking from this advantage;
- educational process is perceived as cheerful and fascinating occupation, interesting to study;
- educational process become visualized;
- complex challenges easily break over a subtask, solution of each task is rewarded;
- students start looking for internal motivators for further training;
- difficulty levels which chosen by the pupil.

The effective gamification of educational process demands wide use of awards that can organized in:

- virtual game subjects, which receive studying for achievement of a goal;
- trophies;
- unlocks, which get access to new areas of the virtual environment (levels, quests or valuable information).

In the majority of the modern programs based on gamification principles uses some methods of motivations, because different students meet various game and educational skills.

Disclosure statement

No potential conflict of interest was reported by the authors.

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