Analysis of methods for developing educational computer games

Marina Lazareva and Alexander Gorovik

Abstract. The article discusses methods for developing educational computer games and analyzes them in order to determine the main features of each method when developing such games. The key aspects of methods for developing educational computer games are presented and the features of each aspect are identified. Detailed diagrams of the components of game design development, learning concepts, interactivity and adaptability, and the use of multimedia have been constructed. A comparison of educational and entertaining computer games was made. As a result of the analysis, the main features of each method under consideration for educational computer games were identified, the main differences between educational and entertaining computer games were identified in terms of target orientation, audience covered, content, scenario and methods used. In the course of the analysis, a theoretical conclusion was made about what features of the development of each of the methods of educational computer games are the main ones and their impact on the effectiveness.

1 Introduction

Currently, information technologies are developing rapidly and penetrating into a wide variety of areas of activity. In the process of their development, educational computer games have become widely used in the modern educational process [1]. Such games are an effective tool for transferring knowledge and skills in a playful way. They combine educational goals with an interactive, fun learning process. Educational games can also be tailored to individual characteristics, needs and preferences, based on knowledge, style and learning difficulty. But the development of educational computer games requires special methods and unconventional approaches. Currently, this is an urgent task, since in the development process it is necessary to take into account many factors, such as the features and specifics of training, the age of the student, the use of innovative approaches and solutions, and much more [2].

The object of study in this article is educational computer games developed for use for educational purposes. The subject of the research is methods for creating educational
computer games. The purpose of the study is to analyze development methods and determine the features of such methods for educational computer games.

The relevance of this study is due to the need to look for new approaches to the learning process, to identify the most effective ways, using information technologies taking into account the interests and needs of modern students, to increase the motivation and effectiveness of learning [3]. One such approach is the use of educational computer games in the learning process. They can be adapted to various formats and learning environments, such as electronic, distance or blended learning, which is currently relevant [4, 5]. In this area there are many unresolved issues and problems related to models, methods and technologies for developing, assessing and analyzing educational games.

Research on the influence of computer games on the learning process has been carried out by many scientists. James Paul Gee studied the use of computer games in education [6]. Carrie Heeter conducted research on the use of games in learning and development [7]. Kurt Squire considered the influence of computer games on learning and the development of social skills [8]. Richard Mayer studied the effectiveness of learning using multimedia materials, including interactive games [9], Maksimova N.A. and Gavrilova T.I. studied the specifics of using educational computer games in the educational process [10].

This study has a novelty, which lies in the approach to the analysis of currently available methods for developing educational computer games, determining the features of such methods and their impact on the effectiveness of learning.

Having studied the problem, the authors considered the hypothesis: Computer games with educational content can be an effective tool for conveying knowledge and skills in a game mode. The development of such games requires special methods and solutions that differ from the development of entertainment games. Developing educational computer games requires a combination of skills in game design, psychology, education, and programming.

2 Method

Let's compare educational and entertaining computer games. Educational and entertaining computer games are two separate types of games that differ in their goals, audience, content, scenarios and techniques (Figure 1).

![Fig. 1. Comparison of educational and entertaining computer games](image)

Target. Educational games are created to convey specific knowledge and skills using a gaming form. Entertaining games have a different goal - entertainment, pleasure, relaxation.
Audience. Educational games are usually aimed at people with an educational need or interest. Entertainment games usually target a large and diverse audience that chooses games according to their tastes, desires, moods and preferences.

Content. Educational games are based on a specific topic or discipline that needs to be learned and/or understood. The content of entertaining games should attract attention and interest, so they can have any themes or a variety of genres.

Scripts. Educational games make learning actionable and adaptable to different situations by using realistic scenarios. Entertainment games are based on fictional or fantasy scenarios to make the game fun and exciting [11, 12].

Methods. Educational games require effective teaching and assessment. They use various pedagogical and psychological methods. Entertaining games require a high level of engagement and enjoyment from the game. Such games use various game design methods.

In general, the development of educational computer games can be represented in the form of a diagram (Figure 2).

Fig. 2. Development of educational computer games

Carrying out a detailed analysis, we explore the features of the main methods for developing educational computer games. Having reviewed the works of the authors [13-16], the main methods were identified, including game design, the concept of learning, interactivity and adaptability, and the use of multimedia.

Game design. Includes defining game goals, balancing difficulty, creating rewards, etc. When developing educational computer games, game design has its own characteristics. Let's analyze some of them:

- Target orientation. The game design of educational games should be focused on achieving educational goals and designed in such a way that players can learn specific knowledge and skills through the game. James Paul Gee in his works "What Video Games Have to Teach Us About Learning and Literacy" and "The Anti - Education Era: Creating Smarter Students through Digital Learning" [17] examines the role of digital technologies and games in modern education and offers alternative approaches based on ideas from game design and situated learning.

- Balance between learning and fun. Educational games should strike a balance between educational purpose and entertainment [2]. A game needs to be interesting and attractive enough to keep players motivated to continue playing, but it must also provide educational content [18].

- Difficulty progression. The game design of educational games involves a gradual increase in complexity, with the goal of methodically acquiring knowledge and skills. One of the ways to achieve this is by increasing difficulty levels and introducing new tasks.

- Feedback, evaluation, motivation. The game design of educational games should include feedback and evaluation systems so that players can be informed about their progress and mistakes. Elements must be included to keep players motivated. This can be achieved through systems of awards, achievements, and competitions. The learner receives immediate information about his actions and their consequences. This helps to understand what he is doing right and what he needs to improve.

Training concept. These include defining educational goals, selecting appropriate teaching methods, and creating teaching materials. Let us analyze the features of this aspect for educational computer games.
- Educational purposes. It is necessary to determine specific educational goals that need to be achieved during the game. Such goals could be specific knowledge, skills or competencies.
- Teaching methods. Various educational methods can be used: simulations, puzzles, assignments, group methods and others to help acquire knowledge and develop skills [19].
- Content of training. The learning concept determines what content will be presented in the game. It can be in the form of texts, graphics, animations, videos or other multimedia elements. The training content should be structured and organized in such a way that students can easily understand and assimilate the information presented.
- Personalization of learning. Some educational games may offer the opportunity to personalize learning to suit different abilities and levels of knowledge. Personalized learning can include adaptive systems that automatically adjust the game’s difficulty level, or provide additional support when needed.

**Interactivity and adaptability.** Educational games typically offer interaction with the game world and feedback on one's actions. When developing educational computer games, interactivity and adaptability have the following features:
- Active participation. Allows you to make decisions, perform tasks, actions and see the results of your actions. This helps to better absorb knowledge and develop skills.
- Variability and nonlinearity. Allows you to find different paths and strategies. Educational games can provide functions for choosing different solutions and exploring educational material. This promotes flexibility and individualization of learning.
- Various ways to interact. It is necessary to provide the student with a variety of opportunities to connect with the game world. This may include the use of keyboards, mice, touch screens, voice control, controllers and more. A variety of interaction options allows you to choose the most convenient and effective method of contact.
- Social interaction. Provides ways for students to interact socially. Educational games can provide opportunities for cooperative play, competition, shared problem solving, and shared experiences. This promotes collective learning and the development of communication skills [20].

**Use of multimedia.** Educational games can use various multimedia elements such as graphics, animation, sound and video to enhance learning and make them more attractive. When developing educational computer games, the use of multimedia has its own characteristics:
- Visual elements. Educational games use images, animations, and graphics to visualize information and concepts. Visual elements help to better understand and remember the material, as well as make the game more attractive.
- Audio effects and music. It is the use of sound effects and music to create atmosphere and emphasize the most important points. Sound effects help you navigate the game world and receive feedback on your actions. Music sets the mood and enhances the emotional appeal of the game.
- Video and animation. Educational games use video and animation to demonstrate processes, phenomena, examples, or explain complex concepts and concepts. With their help, you can create interactive scenarios where the learner can observe and interact with various elements.
- Text materials. This is an opportunity to provide information, instructions and explanations. The text can be in the form of dialogues, tips, tasks or information blocks. Text materials should be clear, understandable and easy to read.

To obtain the results of the analysis of methods for developing educational computer games, the features of each were considered: game design, learning concepts, interactivity and adaptability, and the use of multimedia. The main ones were identified. To obtain the
results, an analysis of literary sources, experience, compiled diagrams (Figure 3-6) and studies of successful modern educational computer games were used.

Fig. 3. Scheme for developing game design for an educational computer game

Fig. 4. Scheme for developing the concept of teaching an educational computer game

Fig. 5. Scheme for developing interactivity and adaptability of an educational computer game
3 Results and discussions

As a result, an analysis of methods for developing educational computer games showed that the effectiveness of learning largely depends on the quality of game design, the concept of learning, the use of interactivity and adaptability, and the use of multimedia. Of the many features of each method, characteristic ones were identified. The results are shown in Table 1.

Table 1. Table of features of the main methods for developing educational computer games

<table>
<thead>
<tr>
<th>Game design</th>
<th>Training concept</th>
<th>Interactivity and adaptability</th>
<th>Using multimedia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target orientation</td>
<td>Educational goals</td>
<td>Active participation</td>
<td>Visual elements</td>
</tr>
<tr>
<td>Balance between fun and learning</td>
<td>Teaching methods</td>
<td>Variability and nonlinearity</td>
<td>Audio effects and music</td>
</tr>
<tr>
<td>Difficulty progression</td>
<td>Training content</td>
<td>Different ways to interact</td>
<td>Video and animation</td>
</tr>
<tr>
<td>Feedback, evaluation, motivation</td>
<td>Personalization of learning</td>
<td>Social interaction</td>
<td>Text materials</td>
</tr>
</tbody>
</table>

Game design plays a key role in creating engaging and effective educational computer games. Games with a good focus, a reasonable balance between learning and entertainment, motivation and feedback stimulate students’ interest and help them acquire new knowledge and skills.

The concept of learning in educational computer games is an important aspect. Correctly defined educational goal, learning content, selected teaching methods and the use of pedagogical methods and strategies in combination with game elements increase learning efficiency and motivation.

The interactivity and adaptability of educational computer games provides the opportunity for active participation, a rational way of interaction, various communication options and improves the quality of learning.

The inclusion of multimedia in the development of educational computer games makes it possible to use various resources, such as video, sound, animation, which enrich the educational process and make it more interactive and exciting.

These methods and approaches allow you to create effective learning tools.
4 Conclusion

The study reviewed the analysis of literary sources, constructed development schemes, and identified the features of each method. This allowed us to gain a deeper understanding of the complexities and nuances of developing effective educational computer games. Analysis of development methods allowed us to determine the most effective approaches and strategies that contribute to achieving high quality learning and user interest.

The conclusion of this study: The main difference between educational and entertaining games is their main goal - education versus entertainment. Educational computer games are a significant tool for acquiring knowledge. The hypothesis is confirmed. Further research in this area could help improve the efficiency and quality of educational computer game development.

References

18. O.A. Shabalina, P.N. Vorobkalov, A.V. Kataev, Open Education J. 2, 290-294 (2011)
20. V.V. Savchuk, Media Philosophy XII. Game or Reality? Experience of Research on Computer Games (Conflictology Development Fund, St. Petersburg), 117-134 (2016)