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Using the Project-Based Learning Method in the Development of Games on Unity to Develop Creative Thinking



Abstract

The article explores the development of creative thinking through the application of the project-based learning method in game development using the Unity engine. Currently, the project-based method is widely used as an effective approach that promotes motivation, teamwork, productive communication, and problem-solving abilities. Since the aim of the study was to determine its impact on creative thinking, a set of research methods was applied. The study had a quasi-experimental design. A total of 78 students participated in the pedagogical experiment: 40 were assigned to the experimental group and 38 to the control group through random assignment. The experiment was conducted based on a methodological learning system that linked the project-based method with different game genres developed in Unity. To assess the level of creative thinking, Torrance's test was administered, focusing on such parameters as fluency, originality, elaboration, and flexibility. In addition, a student survey was conducted to evaluate their satisfaction with the learning process and to identify the main benefits and drawbacks of implementing the project-based method. The results were positive, confirming the effectiveness of the project-based approach in fostering creative skills.



Keywords: project-based method, game development, creative thinking.

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Introduction

Nowadays, the problems arising in the sphere of education require innovative, original and modern solutions. This undoubtedly makes the development of creative thinking skills particularly relevant. In digital education, especially in the context of teaching media and STEM disciplines, there is a growing demand for pedagogical methods aimed at developing creativity. In this context, the project-based learning method is an effective way to develop students' responsibility, critical and creative thinking by applying their ideas to real-world problems.

Game development is interdisciplinary, so it is easy to combine with the project method. The Unity environment is a professional and widely used game engine for game development. It can be an interactive, visually rich and meaningful platform for students' creative projects.

Creative thinking is the ability to generate unique, flexible and expressive ideas. In 1966, Torrance identified the main characteristics of creative thinking: fluency, originality, elaboration, and flexibility (Kim, 2017). Creative thinking includes higher order skills such as observation, discovery, analysis, hypothesizing, testing, problem solving and communication (Buyuktaskapu, 2014). To develop these skills, the project-based learning method is particularly effective. In the process of creating a project, students interact with each other, looking for ways to solve different problems. This, in turn, gives them the opportunity to analyze existing solutions and generate new ideas. Creative thinking is one of the most important skills of the 21st century (Chien et al., 2010). In students with a high level of creative thinking, semantic memory is associated with a larger associative search and has a complex structure (Kenett, 2024).

To foster creativity in educational institutions, it is necessary to create learning environments that encourage exploration, challenge and meaningful problem solving.

Unity is a 2D and 3D game development platform that supports C# scripting (Unity Technologies, 2023). Its visual editor and developed community allow integrating different resources and using them for educational purposes. Unity is an excellent environment for creative projects, as it allows to combine technical skills (programming, physics) with artistic skills (design, animation).

Unity is a popular game development system that provides developers with fundamental features and tools for creating games and other interactive experiences. It has features such as cross-platform development, visual editor, asset management, scripting, physics, graphics and rendering, animation, audio, artificial intelligence and navigation, multi-platform support, physics-based shaders, analytics, monetization solutions, cloud services, etc. (Parikshith, 2017).

The aim of the study is to develop creative thinking through the application of the project method in game development.

Objectives of the study:

- Using Unity game engine for game development;
- Determining the impact of the project method on the development of creative thinking.

Materials and methods

The research was conducted in several stages and was quasi-experimental in nature. It was aimed at determining the influence of project-oriented method on the development of creative thinking of students. The development of digital projects (games) using the Unity game platform was used as the basis of project activity. Before and after the implementation of the project method a comparative analysis of the results of the experimental and control groups was carried out.

The study involved third-year students of the educational program “Information Technology” at the bachelor's degree level. The total number of participants amounted to 78 people who were randomly divided into two groups. In the experimental group, 40 students were trained in the project method and developed their own games in the Unity environment. In the control group, 38 students were trained using the traditional method. All participants had previously, in previous courses, acquired basic programming skills and learned the basics of working with Unity. For 10 weeks, students worked in teams to create projects that included the following stages:

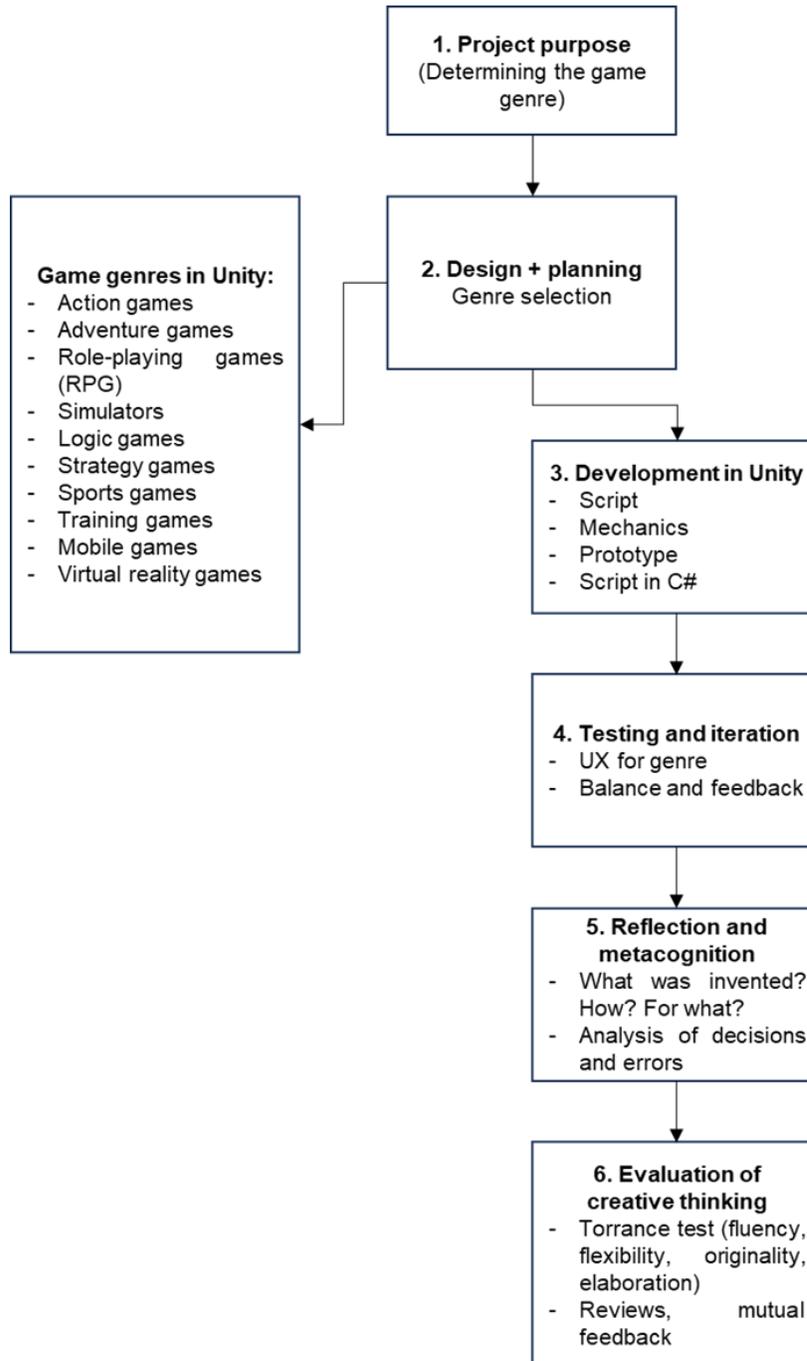
- Generating a project idea;
- Designing game mechanics;
- Creating a prototype in Unity;
- Testing and launching;
- Presentation of the developed project.

The learning process included continuous discussions, intermediate control and collective analysis of the decisions made. While the students in the control group also studied topics related to game development, they did not perform complex project assignments.

The research methods were implemented through a methodical teaching system linking the project method to the genres of games created in Unity (Figure 1).

Figure 1

A teaching methodology system linking the project method to game creation genres in Unity



The Unity game engine helps to create games of various genres for different platforms. Notable project types include the following:

- **Action games:** With its robust physics engine and animation system, Unity enables developers to create games with realistic movement and interactivity. This genre includes shooters, platformers, and survival games.

- **Adventure games:** Unity's visual scripting system and resource storage capabilities make it easy to create compelling story-driven adventure games. Developers can create interactive worlds, NPC characters, sprites, and puzzles, engaging players in an interesting story.

- **Role-playing games (RPGs):** Unity's flexibility allows developers to build complex RPG systems with character customization, inventory management, and branching storylines. You can also create vast open worlds to explore.

- **Simulations:** The physics engine and scripting capabilities allow you to create realistic simulations. Whether it's an airplane simulator, urban planning simulator, or agriculture simulator, Unity offers the tools for an engaging and believable experience.

- **Puzzles:** an intuitive interface and drag-and-drop functionality make Unity convenient for developing casual puzzles. Developers can easily implement simple mechanics as well as complex logic problems, from three-in-a-row games to physics-based puzzles.

- **Strategy games:** Real-time multiplayer capabilities and artificial intelligence make Unity suitable for strategy games. Developers can implement games in which players compete against each other or the AI, with elements of resource management, tactical decisions, and strategic planning.

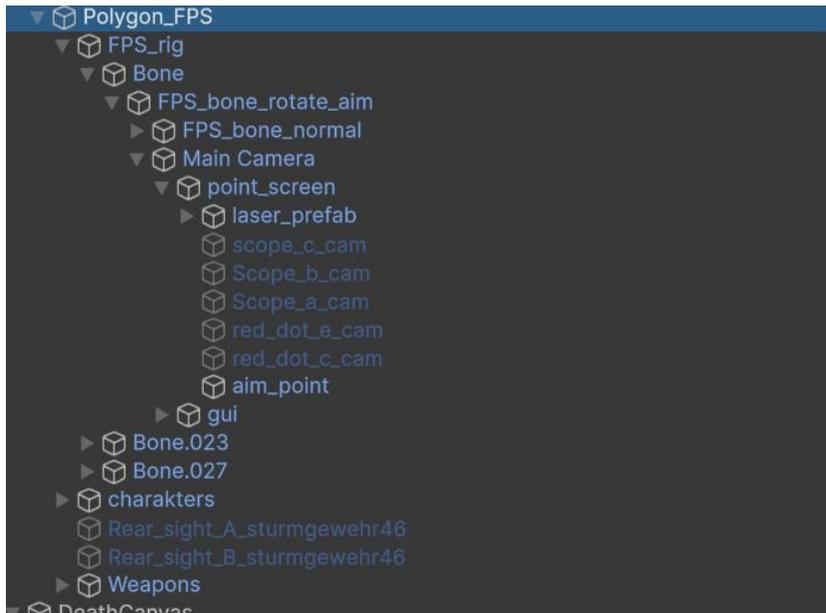
- **Sports games:** Unity's physics engine and animation system allow you to create realistic sports games. Whether it's soccer, basketball, tennis, or auto racing, players get a dynamic and authentic sports experience.

- **Educational Games:** The visual scripting system and resource storage capabilities make it easy to design educational games that entertain and educate at the same time. You can create interactive lessons, quizzes, and simulators for learning math, science, history, or languages.

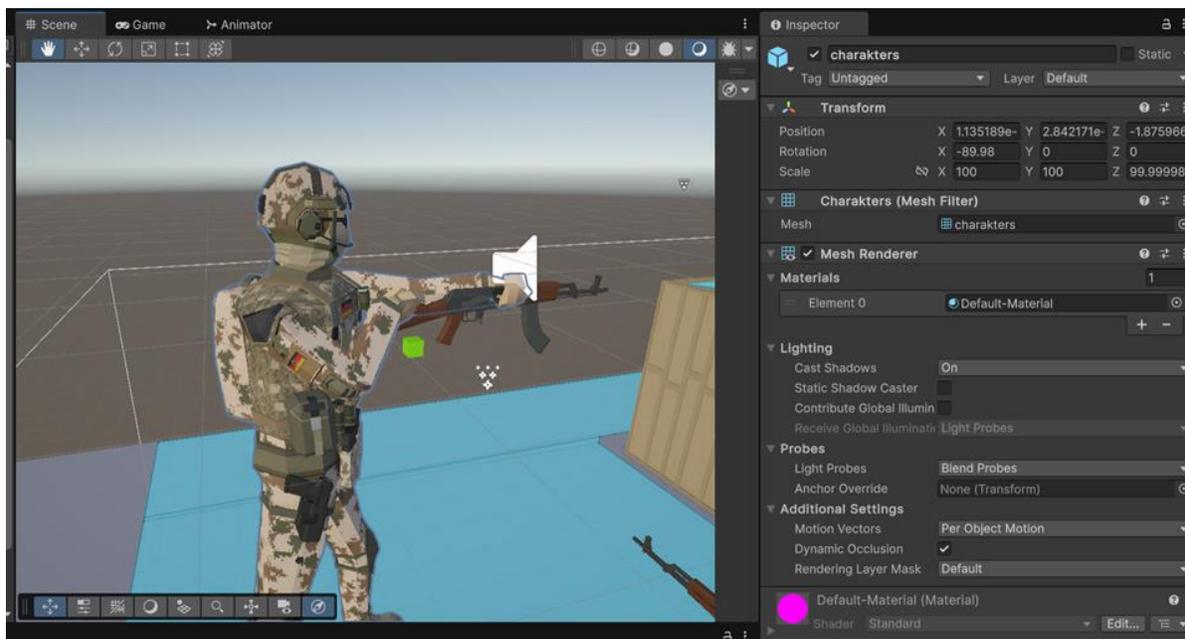
- **Mobile gaming:** cross-platform capabilities make Unity a popular choice for mobile game development. With Unity, developers can create games for iOS and Android, reaching a wide audience.

- **Virtual Reality (VR) games:** Unity's support for VR makes it a great tool for developing immersive virtual reality games. Developers can utilize Unity's resources and tools to create immersive VR worlds and unique gaming experiences.

In the process of realizing the proposed projects, students added their own characters, combining model, animation, controller, and motion logic (Figure 2). For this purpose, they used sets from the Polygon collection or resources stored in the Unity Asset Store.

Figure 2*Objects integrated into a scene in Unity*

The character placed on the stage is copied to the hierarchy panel as a prefab, making sure that it is positioned above the surface of the space (see Figure 3). This ensures correct operation of the controller.

Figure 3*Objects integrated into the Unity scene*

Three types of enemies were developed: zombies, flying robots, and warriors (Figure 4). Each of them consists of unique models and animations. According to the game's logic, enemies patrol through specified points until they detect the player, after which they begin pursuit and open fire if necessary. Their behavior, including damage infliction and recovery, as well as defeat animations, is controlled by scripts.

Figure 4

Types of enemies in game



The next example of a project created in Unity is an animation of weather phenomena using particles: modeling rain, wind, fog, fog, lightning, and snowfall (Figure 5).

Figure 5

The weather animation



The real-time animation of dynamically changing weather conditions using the Unity game engine aimed to create a three-dimensional environment with an emphasis on environmental transitions and immersive visual storytelling.

The design goals were to understand how to model natural phenomena using particle systems and shaders, create a system capable of switching between different weather

conditions, explore time-of-day changes, skybox transitions, lighting changes, and the use of sound effects to enhance the perception of rain and other phenomena.

The Torrance methodology was used to assess changes in the learners' level of creative thinking induced by these projects. It includes four parameters: fluency, originality, elaboration, and flexibility.

The questionnaire method was used to assess subjective changes in perceptions of creativity, engagement and interest.

Teacher observation and diaries recorded cases of initiative, originality and ability for non-standard problem solving in the process of working on projects.

For data processing we used methods of statistical analysis, in particular Student's t-test for dependent and independent samples.

In qualitative analysis, content analysis of the project products (games) was conducted to identify signs of creativity, innovativeness and complexity of the implemented solutions.

Research ethics were strictly followed during the study. Participants were informed about the purpose of the study and voluntarily consented to participate. Data anonymity was guaranteed.

Results and Discussion

To evaluate the effectiveness of the project-based learning method in game development in Unity, we measured the level of creative thinking in the control and experimental groups. For this purpose, the Torrance Creative Thinking Test was used to assess the key parameters of creative thinking.

At the beginning of the experiment, there were no statistically significant differences between the control (N = 40) and experimental (N = 38) groups. The average indicators of both groups were within the norm for this age category ($p > 0.05$).

The results of the pedagogical experiment aimed at developing creative thinking skills in Unity using the project method showed a significant increase in the level of creative thinking in the experimental group. The obtained values are summarized in the table (Table 1).

Table 1
Results of Torrance test

Parameter	Control group	Experimental group	Dynamics in the Experimental group (%)
Fluency	42,3 ± 3,1	55,6 ± 3,4	+31,5%
Flexibility	38,5 ± 2,7	52,1 ± 3,0	+35,3%
Originality	40,7 ± 2,9	58,9 ± 3,2	+44,7%
Elaboration	35,1 ± 3,3	48,3 ± 3,5	+37,6%

The experimental group showed significant improvement in all four parameters. The greatest increase was noted in the indicator “Originality (non-standard solutions)” - 44.7%, which indicates the effectiveness of project-based learning for the formation of the ability to create non-standard, unique solutions in game development.

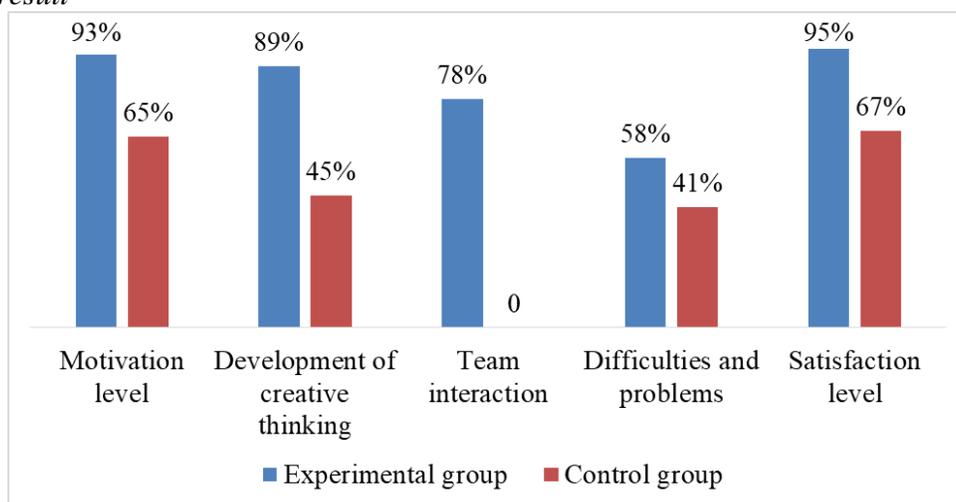
Participants noted an increase in motivation, active exchange of ideas in teams, and an increase in the ability to find multiple variants of implementing a single game mechanic.

The control group also showed a slight increase in results (within 5-7%), which may be related to the general influence of the learning environment, but these differences are statistically insignificant.

Thus, the application of the project-based learning method in the process of game development in Unity contributes to the reliable growth of the main parameters of creative thinking - fluency, originality, deployment and flexibility. The obtained data confirm the effectiveness of this pedagogical model in the formation of abilities to search for new solutions, create a non-standard product and its realization within the framework of team activities.

In order to assess the subjective perception of the effectiveness of project-based learning in game development in Unity, an anonymous questionnaire was administered to the participants of the experiment. The survey was conducted at the end of the training module and included 15 questions aimed at identifying the level of students' motivation, self-esteem, development of creative thinking, quality of team interaction, complexity of tasks and understanding of their own role in the project. The purpose of the survey was to determine the degree of satisfaction with the learning process, as well as to identify the main positive and negative aspects of the implementation of the project-based learning method (Figure 6).

Figure 6
Survey result



93% of students in the experimental group noted that the project form of learning significantly increased their motivation and interest in amounted to 65%.

89% of students in the experimental group indicated that when creating a game in Unity they had to look for non-standard ways to realize ideas. 83% confirmed that the project format allowed them to reveal their creative potential. In the control group, the corresponding figures were 45% and 37%.

78% of participants in the experimental group noted the positive impact of teamwork in the project. Students emphasized that sharing ideas, joint search for solutions and team brainstorming were important factors in developing creative skills. In the control group, where learning took place individually, this aspect was not evaluated. 58% of participants in the experimental group indicated that planning and controlling time was the greatest difficulty. 41% reported difficulty in combining ideas into a workable product. In the control group, the main difficulties were identified as: lack of motivation to independently search for non-standard ideas (64%) and lack of creativity-oriented tasks (52%).

According to the level of satisfaction, 95% of students in the experimental group expressed their willingness to participate in similar projects in the future. In the control group, 67% of students stated that they would like to try the project-based learning format to increase motivation and unlock creativity.

In general, the experimental group demonstrated a significantly higher level of satisfaction with the learning process and increased motivation. The students noted that working in Unity in the format of full-fledged game creation contributes not only to the improvement of the programming level, but also to the development of the ability to search for non-trivial solutions. While the control group perceived the course formally, students from the experimental group attached importance to the meaning of the work performed.

The results of the questionnaire confirmed the effectiveness of project-based learning for the development of creative thinking when creating games in Unity. The combination of personal responsibility, joint teamwork and freedom in making design and technical decisions provides not only the growth of creative skills, but also a high level of motivation and satisfaction with the educational process.

Conclusion

In conclusion, the effectiveness of applying the project-based learning method in game development in Unity for developing learners' creative thinking was confirmed. The following results of the study provided the basis for this conclusion:

The experimental group, which worked in the project-based learning format, significantly improved performance on the key parameters of creative thinking - fluency, flexibility, originality and detailing of ideas. The greatest increase was observed in the indicator of originality, which indicates the effectiveness of the project model in forming the ability to search for non-trivial solutions. According to the results of the questionnaire,

the project-based learning format promotes sustainable motivation, active participation in the process of game creation and disclosure of personal creative potential.

The project-based learning method promotes not only the development of creative skills, but also the formation of such key competencies as critical thinking, the ability to search for optimal ways to implement ideas, planning individual learning and effective teamwork.

Further development of the project method can be associated with the integration of interdisciplinary design and the use of modern VR/AR technologies, as well as gamified educational platforms for the formation of a wide range of creative and professionally relevant competencies.

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