THE POSSIBILITIES OF USING GAMIFICATION ELEMENTS IN TEACHING MATHEMATICS

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ABSTRACT

The purpose of this study is to determine the possibilities of using gamification elements to improve the quality of education as a result of increasing the motivation of students in mathematics education. For this purpose, the works of foreign and domestic scientists were reviewed and analyzed, and their definitions of the concept of gamification were given. As a result, it was concluded that gamification is the widespread use of games, their elements and methods in non-game situations, which should not be considered the same as game exercises.

The article describes examples of services for using gamification elements in teaching mathematics, including the possibility of the computer application "Joyteka". Analyzing game elements according to Kevin Werbach's method of introducing gamification into the educational process, examples of games for teaching mathematical modules were considered.

The use of gamification elements in teaching mathematics allows to differentiate the educational process, to take into account the needs of different groups of students. As a result, their interest in learning increases, external motivation gradually turns into internal motivation. Thus, the behavior of students changes: the process of providing mutual assistance develops in the study group; in the course of doing homework, there is an opportunity to gain deeper knowledge; interest in the subject increases; enthusiasm for solving problem situations and learning increases. These changes have a significant impact on the effectiveness of school mathematics teaching.

Keywords: Mathematics, Education, Learners, Gamification, Game Technology.

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OYUNLAŞTIRMA UNSURLARINI MATEMATİK ÖĞRETİMİNDE KULLANMA OLANAKLARI

ÖZET

Bu çalışmanın amacı, matematik eğitiminde öğrencilerin motivasyonlarının artması sonucunda oyunlaştırma unsurlarının eğitim kalitesini artırmak için kullanılma olanaklarının belirlenmesidir. Bu amaçla yerli ve yabancı bilim adamlarının çalışmaları gözden geçirilerek analiz edilmiş, oyunlaştırma kavramına ilişkin tanımları verilmiştir. Sonuç olarak, oyunlaştırmanın, oyun dışı durumlarda oyunların, unsurlarının ve yöntemlerinin yaygın kullanımı olduğu ve oyun alıştırmalarıyla aynı görülmemesi gerektiği sonucuna varılmıştır.

Makale, bilgisayar uygulaması "Joyteka" olasılığı da dahil olmak üzere matematik öğretiminde oyunlaştırma öğelerini kullanma hizmetlerine ilişkin örnekleri açıklamaktadır. Kevin Werbach'ın oyunlaştırmayı eğitim sürecine dahil etme yöntemine göre oyun öğelerini analiz ederek, matematik modüllerini öğretmek için oyun örnekleri ele alındı.

Oyunlaştırma unsurlarının matematik öğretiminde kullanılması, farklı öğrenci gruplarının ihtiyaçlarını dikkate alarak eğitim sürecini farklılaştırmaya olanak tanır. Sonuç olarak, öğrenmeye olan ilgileri artar, dış motivasyon yavaş yavaş iç motivasyona dönüşür. Böylece öğrencilerin davranışları değişir: çalışma grubunda karşılıklı yardım sağlama süreci gelişir; ödev yaparken daha derin bilgi edinme fırsatı vardır; konuya ilgi artar; problem durumlarını çözme ve öğrenme coşkusu artar. Bu değişikliklerin okul matematik öğretiminin etkinliği üzerinde önemli bir etkisi vardır.

Anahtar Kelimeler: matematik, eğitim, öğrenenler, oyunlaştırma, oyun teknolojisi.

1. INTRODUCTION

Today, in the context of the modernization of the country's education system, high demands are placed on the professional training of the teacher, his pedagogical skill, competence, erudition, intellectuality and general pedagogical culture. This is due to the significant changes in the education system of the Republic of Kazakhstan caused by its reorientation to the ideas of humanism. At the same time, on the one hand, it is important to resolve the contradiction between the high level of requirements for the volume and level of professional skills determined by the state education standard and qualification characteristics, and on the other hand, the increase in the requirements for the quality of mathematical knowledge and skills, as well as the reduction of study hours for studying mathematics.

In addition, the importance of mathematics in today's world has led to increased emphasis on effective teaching of mathematics at all levels of education. However, it is not difficult to see that the vast majority of today's students have little interest in mathematics.

According to Dooley T, et al., every student has the opportunity to solve mathematical problems and use their knowledge and skills to connect with the world around them. This requires making changes in teaching, making connections between mathematics and real learning [1].

Usually, changes in the content of school mathematics are related to changes in the structure of university mathematics education. For example, today mathematics courses such as Discrete Mathematics, Operations Research, System Analysis, Game Theory, Decision Theory have become general, and newly Financial Mathematics, Actuarial Mathematics, Risk Theory, etc. new applied courses appeared. This, in turn, forces us to consider the possibilities of bringing necessary changes to both the content of school mathematics and the teaching methodology. But how to expand an already overburdened school curriculum? Of course, expansion is not possible. Therefore, this indicates the need to revise the content and improve the teaching methodology by replacing some complex materials that are not widely used with new materials.

Thus, the urgent problem of modern pedagogy is to search for teaching tools, forms and methods that contribute to the formation and maintenance of positive internal motivation in classes. These researches in pedagogy also require the identification of new methods to improve the teaching of mathematics, because the use of new methods in teaching is important. As can be seen in the practice of teaching mathematics at school, there is often a decrease in motivation to study in 5-6th graders. For this reason, researches are being conducted to use different methods in order to interest them.

Since the effectiveness of teaching is determined by the activity of the student, his orientation to the cognitive process, the child should be motivated not only for the result, but also for the process of educational activities. In this regard, T. Dooley [1] argued that using one of the latest methods in education - gamification (game technology) in order to increase student motivation and learning progress, mathematics can be perceived as a valuable prospect for representing and shaping the world.

The use of game technology in pedagogical practice has been known since ancient times. Along with work and study, play is one of the main human activities, because a person has a natural inclination to play. Therefore, game technologies are an integral part of pedagogical technologies. In pedagogical theory and practice, the problem of using game technologies in the educational process is not new, it is known that it has become an object of research in the educational and educational process.

There are many scientists who are engaged in explaining game theory, its methodological foundations and social nature, its importance for the development of the student in pedagogy. They are: Ya.A. Komensky, I.G. Pestalozzi, R. Owen, F. Froebel, K.D. Ushinsky, P.F. Lesgaft, L.N. Tolstoy, N.K. Krupskaya, A.S. Makarenko, V.A. Sukhomolinsky et al. Prominent psychologists to create game theory and practice L.S. Vygotsky, A.N. Leontiev, D.B. Elkonin, P.P. Blonsky et al. contributed. In addition, German educators F. Schiller, K. Gross, W. Wundt and the English sociologist G. Spencer paid special attention.

L.S. Vygotsky, a psychologist-scientist who dealt with the problem of the "zone of immediate development" of the theory of developmental learning, commented on children's play: "even if the child is small during the game, his thinking and actions often seem adult" [2].

V.V. Davydov said in his work that a properly organized game teaches a child many things necessary for life, and the child's new psychological state is reflected in the content of the game [3].

In addition, Kazakh intellectuals and scientists-pedagogues Y. Altynsarin, A. Baitursynov, M. Zhumabaev, Zh. Aymauytov, M. Dulatov, etc. determined the role of the game in the comprehensive development of the child, showed that the game has its own influence on the thinking, feeling, will, behavior, consciousness of the growing person, therefore, it is necessary to use it appropriately in the learning activity. For example, let's cite M. Zhumabayev's comments about the game: "A child's imagination is revealed especially in your mind", "A game is a life experience for a child" [4].

K.D. Ushinsky [5] pointed out that appropriate use of game elements during teaching facilitates the learning process of students. Meanwhile, O. N. Igna pointed out: "game technology applied in the educational process is fully recognized, it is very effective, universal, easy to implement, suitable for any educational subject and solves all educational and developmental tasks" [6].

Today, the phenomenon of play seems to be less important for pedagogical research. Also, in public opinion, the practice of computer games is recognized as a waste of time, with the risk of addiction. However, researchers noted that "the negative effects of computer games are greatly exaggerated, and the positive effects are understudied" [7].

Therefore, the transition to a new paradigm of education, a digital education system, forces a new approach to the role of games in education, including computer games.

In fact, today's children are very interested in the opportunities offered by the "Internet": there is a significant dependence on digital technologies, and online communication is predominant. In the digital environment, elements of gadgets such as multimedia, interactivity, availability of presented information attract the attention of students. Many studies have shown that various games and game applications have a special role in forming the interest of teenagers in the virtual environment.

Thus, the contradiction between the demands of modern reality and the increasing demands for the quality of mathematical knowledge and skills, which meet the capabilities of teenagers born in the digital society, defines our research problem and goal.

The problem of the study: in the case of digitalization, the space of school education lags behind the real world of children, that is, the gap between reality and learning.

The purpose of the study: to determine the possibilities of using gamification elements to improve the quality of education as a result of increasing the motivation of students in mathematics education.

2. METHOD AND MATERIALS

The theory of learning develops the methodological basis of research (K.D. Ushinsky, L.S. Vygotsky, V.V. Davydov, D.B. Elkonin, etc.); modern pedagogical technologies and active methods of teaching, including game technology (A. A. Verbitsky, A. V. Makarov, D. B. Elkonin, V. M. Monakhov, A. N. Leontiev, D. Rakhimbek, A. Abylkasymova , Zh. Karaev and others).

During the study of the proposed work, theoretical methods such as analysis and synthesis, comparison, classification, clarification and generalization were used when using the empirical method of literature research and the accumulated experience within the subject under consideration. In addition, Kevin Werbach's method of introducing gamification into the learning process was considered.

At present, the use of gamification technology in the field of teaching fundamental subjects, which significantly affects the creative results of students, has not been fully implemented. There are almost no domestic publications and methodological materials on this issue. The main challenge is developing the thematic content to make it happen, despite having experience in developing game mechanics and dynamics. Only a specialist in this field, in our case, a mathematician-teacher, can make it or choose it correctly. After all, both the selection of tasks for the game and solving them to test the knowledge of the player are important components.

Gamification is one of the tools that allow taking into account the needs and interests of today's students and developing their cognitive motivation based on it.

The term gamification was first introduced by the American programmer Nick Pelling in 2002, and the term became popular by 2010 [8].

M. Melwin et al. (2017) suggested that gamification was implemented in the early 2000s as a concept of using game design components in a non-game environment [9]. K. Seaborn and D. Fels (2015) stated that there are many definitions of the term gamification, but to date there is no universally recognized logical definition of the term [10].

Today, the word gamification sounds reliable in many areas of human activity and is used to designate a special way of solving various problems of varying degrees of complexity (Table 1).

Table 1: Definition of Gamification Concept

Author or source of information	Gamification is …
Wiki encyclopedia	application of game design elements and game principles in a non-game context [11].
Wikipedia is a free encyclopedia	to attract users and consumers, to increase their involvement in solving application problems, using products, services, using approaches specific to computer games and non-game processes for application software and websites [12].
Wood, L. C. & Reiners, T., 2015	the use of game mechanics and game design elements in non game settings to encourage the achievement of desired outcomes by engaging and motivating users [13].
Bozkurt A., & Genç-Kumtepe E., 2014	implementation of game philosophy that increases personal motivation and makes the process interesting for participants [14].
S. Sezgin et al., 2018	adding planned game elements to processes without game factors [15].
A.Dominguez et al., 2013	implementing game elements in a non-game setting to increase user experience and interest [16].

From the above definitions, it can be seen that gamification is defined as equipping non-game processes with elements of game design.

Finnish researcher Juho Hamari (Hamari J., Koivisto J., & Sarsa H., 2014) presented the results of his empirical study on gamification in his article. Reviewing the increase in published gamification articles, he noted that public interest in gamification is also evident in academic contexts, and that the number of references to the term "gamification" in article titles is growing faster than the number of general search views. Yuho Hamari shows that gamification has become an increasingly popular topic for academic research and that interest in it is increasing every year, as shown in Figure 1 below [17]:
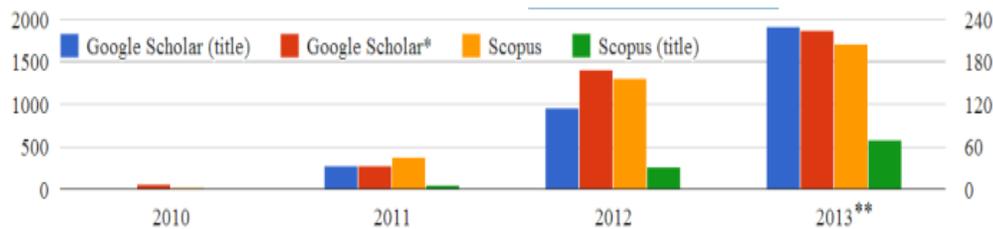

Figure 1: Search Results For The Term "Gamification".

Thus, in his research, Yuho Hamari shows the positive effects of using gamification and concludes that gamification is highly dependent on the context in which it is implemented, as well as the users to whom it is applied.

3. RESULTS

In our research, we understand gamification as the widespread use of games, their elements and methods in non-game situations. Gamification should not be considered the same as game training. In the latter, real games are used to acquire skills and knowledge, while gamification is mainly utilized in a non-game context and depends only on individual components of the game.

Comparing gamification with other game methods, Mario Herger (2012) presents Table 2, which allows us to more clearly define the boundaries between gamification and other types of gaming experiences, which are related but have different phenomena [18].

Table 2: Comparison of Gamification and Other Types of Games

Comparison parameter	Traditional games	Role play games	Business games	Simulation	Gamification
Spontaneous (unexpected)	no	ия	no	no	no
Having rules	yes	no	yes	yes	yes
Having a purpose	yes	no	yes	yes	yes
Structure	yes	no	yes	yes	yes
Real life	no	no	yes/no	yes/no	yes
Systematic	no	no	no	yes/no	yes

This table shows the differences and similarities between gamification and other games. For example, the closest thing to gamification is simulators that create an illusion of reality in a computer environment. However, gamification differs from them in that it uses the mechanics of a real-world computer environment by creating the illusion of a game.

As a result of the analysis of the works reviewed above [8-18], it can be concluded that today the widespread use of game-based adaptive learning systems, the increase of mobile learning applications and new game strategies in educational technology make gamification one of the most important educational trends in the third decade of this century. In addition, opportunities for experiential learning, self-directed learning and lifelong learning increase exponentially, as interest in the learning process provides new knowledge and skills, which in turn expands the scope of interest and increases the level of information gained.

Thus, gamification has become a method of increasing the efficiency of any process. This method helps to avoid boring activities and achieve high focus while performing routine tasks. Gamification can also be considered as a way to keep students' attention constantly active.

Teachers can integrate different types of games and their elements into their offline lessons. And during online classes, intellectual battles, quests, quizzes, interactive polls are conducted using the elements of prediction, search, research, logical conclusion, creative thinking. Gamification in distance learning is used through special software online services.

Examples of services for using gamification in education:

- Motion Math Games – mobile math games (make learning fun and interesting);

- Mathletics is a program for schools, a platform aimed at engaging children in mathematics through games and challenges;

- Khanacademy - free video courses on various subjects;

- Spongelab is a personalized scientific education platform;

- Foldit - solving scientific problems in the form of a puzzle;

- Classcraft is a platform to encourage good behavior and develop cooperation skills, improve child attendance and more.

Classcraft has web and iOS versions and can be understood by both students and teachers. In order to engage players as quickly and as long as possible, the game environment should be full of information and game events, and the user should have a visible shortcut to solving game problems. These characteristics correspond to the educational process on the mobile application platform. Classcraft is played in teams of five to six students throughout the school year. This approach encourages unsociable students to interact with other students in order to win [19].

Currently, the potential of the computer application "Joyteka" for the development of its web quests for the use of gamification in the educational process is high [20]. Basically, "Joyteka" software is a tool for creating web quests. It allows you to create quizzes, games with terms, "exit the room" educational quests. The free version has 15 different rooms to choose from. Web quests can be assigned as homework or conducted directly in class with students. You can use the quest rooms here (Figure 2,3) as you wish, there are no restrictions. In such quests, children have the task of leaving the room using various objects, finding clues and solving logical problems. Hints (tasks) can be solutions, answers to advance the plot of the quest. To find clues, children should consider predictable situations: move a cabinet somewhere, open a safe somewhere, enter a code from the numbers on the clock, water the flowers, charge the phone, etc. At the end of the road, children will be rewarded, because gamification means rewards, points, statuses in games, but it is better to pay more attention to internal "rewards", that is, positive emotions, self-learning, peer recognition of internal achievements, interest.

Figure 2: Traveler's Room   **Figure 3: School Gymnasium**

Any modern gadget and the Internet are suitable for working with web quests. During the use of web quests, students' attention increases, they become interested in mathematics and remember the material well. You don't need special knowledge or skills to use such applications, if you prepare the necessary reports on the chosen topic in advance, it can take from 2 to 10 minutes to compile a web quest.

In the course of our research, the experience of using various quests developed using the "Joyteka" program in teaching mathematics was carried out. As a result, it was determined that they are an important addition to the educational process and allow students to consolidate their theoretical knowledge in practice and develop the necessary study skills.

There was a view that gamification has a great pedagogical potential to increase the activity and motivation of learners.

Basically, a gamified educational course is not a computer game, although sometimes the software that supports the course looks very similar to it because of the game shell. According to the direction of the course, the student performs educational and game tasks at the same time. For example, the task of education in mathematics is to master the concept by performing various mathematical tasks; The task of the game is to collect points for the given tasks within the given time frame or to pass to the next level. In addition, educational goals always take priority, and game goals only help to maintain internal motivation to complete educational tasks.

In general, the use of gamification elements in the learning process includes the following methods [21]:

- attracting and keeping students' attention;

- differentiation of long-term, unclear and short-term, clear goals;

- development and introduction of a system of actual winnings and risks for students;

- establishing a match between students' abilities and the complexity of the tasks to be solved;

- simulation of game situations (during the game, students should form knowledge, skills and abilities in a certain subject area).

Therefore, in order to create game templates, it is necessary to understand the structural components of any game that determine its operation. Kevin Werbach, an associate professor at the Wharton School of Business at the University of Pennsylvania, who teaches an online course on gamification as part of the Coursera online education project, suggests considering all the elements that make up a game using a conventional pyramid consisting of three layers: Dynamics at the top, Mechanics at the middle, and Components at the bottom (Figure 4). This plan by Kevin Werbach is considered as a way to introduce gamification into the learning process [22].
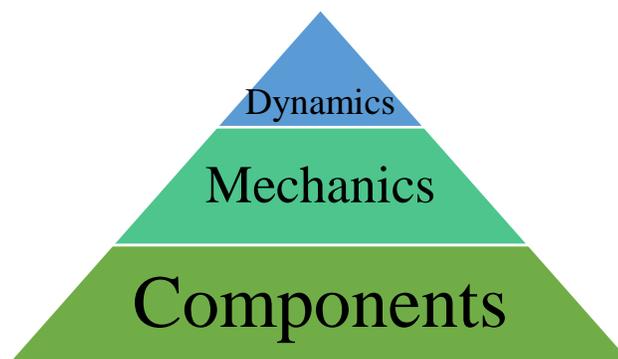

Figure 4: K. Werbach's Pyramid of Game Elements

Each layer of the pyramid has several elements that consist of actions to be performed (Table 3).

Table 3: Layers of K. Werbach's Pyramid and its Elements

Pyramid layers	Elements of the layers of the pyramid
The "Dynamics" layer is the high-level, conceptual elements of the game that represent the "grammar" of the game, its hidden structure, which makes the impression and experience connected, coherent and coherent.	✓ Constraints - Every game has constraints because the game must create meaningful choices and challenges that limit the freedom of the players. ✓ Emotions - the game has a limited range of emotions, however, there are enough emotional mechanisms to enrich the experience and / or effects. ✓ Chronology (narrative) is a structure that unites the parts of the game into a whole. ✓ Progression is a very important element in gamification - it is the feeling that the player has the opportunity to improve and grow relative to the level he started. ✓ Communication is a common connection between people.
The "Mechanics" layer is the actions that drive the gameplay forward	✓ Difficulty - goals in the game that players strive for; ✓ Situation - elements of luck and creation of random variables and parameters; ✓ Competition; ✓ Cooperation; ✓ Feedback - the ability to see how the player works in real time; ✓ Purchase Resources Mining is the process of giving or collecting resources to players that move the game forward; ✓ Reward; ✓ Dealing - buying, selling, exchanging something; ✓ Movement (sequence); ✓ A win-win situation.
The component layer represents the implementation of game dynamics and mechanics	✓ Success; ✓ Avatars; ✓ Collection; ✓ Opening new content; ✓ Gifts and gifts; ✓ Rating of leaders; ✓ Level; ✓ Glasses; ✓ Quests; ✓ Social relations; ✓ Teams; ✓ Virtual goods and goods etc. b.

A pyramid of game components means that higher-level concepts must be supported and revealed by one or more lower-level elements.

4. ANALYSIS

In order to understand and analyze the elements of the game according to K. Werbach's pyramid, let's look at examples of games for teaching mathematical modules given in M.V. Eichhorn's methodological guide [23].

Example 1: The game «Maze», its authors are Abdrashitov and Prokhorenko. The nature of the game is as follows:

1. The goal of the game is to go through the maze and solve the last task.

2. The Maze has doors with coded locks that must be solved to pass through them; if the player does not solve the task hidden in the door code, the path is no longer possible.

3. When solving the code, the door opens and can stay open, but the player can make it difficult for opponents to pass through the doors: if they solve the challenge, they can close it.

4. If the player cannot pass through the door, he can change the path. At this point, he can pass through unlocked or unlocked doors; otherwise, you will need to decode the code set on that door on the way back.

5. After solving the problem, the team informs the driver of its answer and, if the answer is correct, continues on its way; else-continues to solve the task or decides to go another way;

6. If the players meet at the same door, each of them solves the problem, and the first to pass the door can close it or leave it open, and the other player can pass behind the solver without solving the problem.

7. The team that solves the last task wins.

The game includes the following elements:

Dynamics: limitations; emotions; chronology (story); progression;

Mechanics: situation; cooperation; feedback; victory situation;

Components: achievement; quests.

Example 2: "Zombie Invasion" game. The authors who developed it are A.L. Lisok, Y.V. Lenivtseva and T.I. Spiridonova describes the game as follows.

1. The game includes sections of algebra and mathematical analysis.

2. The shell of the game where the mechanics are placed offers 2 game worlds: "the world of the living" and "the world of the dead". The living world is made up of players, the world of the dead is "zombie". At the beginning of the game, players are in a living world. The task of the players is to survive, that is, to leave more than 50% of the group alive at the end of the lesson.

3. The living world is attacked by "zombies", whose main weapon is cards with mathematical problems that need to be solved. Attacked players are isolated from the general group, because here the participants have to solve the tasks on their own. The attacked player has 2 minutes to solve the problem. After two minutes, the "zombies" will check the correctness of the decision of each of the attackers. If the task is solved correctly, the player returns to the living; if mistakes are made in solving the task, the player loses one life. After the first participants solve the tasks, the next ones are chosen and a new two-minute wave of zombie attacks begins.

4. At the start time, each player on the live team has three lives. When the participant loses all three lives, he moves to the world of the dead.

5. In the world of dead participants, there is a necromancer (a sorcerer capable of raising the dead), who is ready to help players return to the living world under certain conditions: they must solve his task. The tasks of the necromancer belong to the second group, the more complex group of tasks; the time for solving them is not limited. When the participant solves the necromancer problem, he will rejoin the team in the living world.

According to the pyramid, the game includes the following elements:

Dynamics: limitations; emotions; chronology (story);

Mechanics: calling; victory situation;

Components: achievement; level; teams.

By completing the above-described games "Maze" and "Zombie Invasion" in terms of educational content, it was observed that the following competences of students are formed as a result of the use of mathematics in education:

- According to the game "Maze": the ability to generalize information, analyze, accept, set a goal and choose ways to achieve it; ability to make oral and written speech logically correct, logical and clear; preparation, presentation and presentation of the results of the performed work; solving problems, taking responsibility; to use the mathematical apparatus and the mathematical model according to the process to solve the tasks; justification of project decisions; abilities to perform experiments.

- "Zombie Invasion" game: decision-making speed; search for errors; ability to identify a simple solution.

One of the important features of the educational game is the existence of an evaluation system based on the following theses: the point system is considered; at the beginning of the quarter, the student starts with 0 points; each task is evaluated for a certain number of points. Therefore, it has a path to good evaluation, which means that at the beginning every student knows that he is equal to others, regardless of his ability. Realizing that the student can make as many mistakes as he wants and that every point counts, the student stops being afraid of making mistakes and focuses on learning.

Thus, gamification of education can be one of the effective methods of increasing internal motivation and enthusiastic learning conditions. After all, it is the process and result of using game methods in non-game situations in order to increase the motivation of learners and their participation in learning and solving various educational tasks.

5. CONCLUSION

Traditional forms of education allow students to acquire only the information base, while gamification elements supplement traditional forms, develop creative thinking and practical skills, teach to show activity in the learning process, allows you to better master the studied material or perform non-standard tasks that develop logical thinking and a creative approach to solving tasks. Therefore, the importance of gamification consists in the formation of a creative personality. The point of gamification is to provide a sense of internal progress. We perceive gamification as a new approach with great pedagogical potential in the organization of learning.

So, the possibilities of using gamification elements in teaching mathematics:

- differentiating the educational process, taking into account the needs of different groups of students, as a result of which their interest in learning activities develops, external motivation gradually turns into internal motivation;

- activation of activity at a high level, which is a source of creativity through movements characteristic of gamification;

- increase the motivation of students and their participation in learning and solving various educational tasks;

- changing the behavior of learners, as a result: the process of mutual assistance develops in the study group; in the course of homework, the opportunity to gain deeper knowledge arises when using various information resources; is interested in solving educational tasks; interest in the subject, motivation to solve problem situations and study increases.

- creating conditions for experience-based learning, as well as self-directed learning and lifelong learning.

Thus, the use of gamification in teaching mathematics helps students to perform tasks independently, to activate creative thinking and imagination, and to increase enthusiasm for learning.

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