Digital Technologies for Introducing Gamification into the Education System in the Context of the Development of Industry 4.0

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ABSTRACT

The main purpose of the article is to model the stages of using digital technologies for introducing gamification into the education system. In recent years, gamification has been constantly on the list of trends in Industry 4.0. It is being researched by specialists in academic and corporate training, as well as by individual educational institutions. Therefore, we believe that we should take a closer look at this technology. The methodology implies the use of information-graphic modelling methods. Based on the results of the analysis, a multi-stage model of the use of digital technologies for the introduction of the gamification system into the educational process for a specific socio-economic system was formed. The study has limitations and they relate to the use of one educational institution and do not take into account all the digital technologies that can be applied in accordance with the research topic. Further research requires the question of analyzing the complexity of the gamification implementation system in modern conditions and determining what negative consequences it can bring to the socio-economic system.

1. INTRODUCTION

Our society is currently undergoing significant changes. This is due to new discoveries in science and technology, the renewal of many areas of human life, and the emergence of Industry 4.0. Thus, society is constantly making a transition to a new level of its existence, and at the same time, there is a need to change the basic social processes taking place in it. All socio-economic systems are being adapted and transformed in their information systems. Perhaps the first such changes relate to education. The educational process must constantly adapt to new conditions of functioning, in particular, the changes have affected the choice of methods and technologies in the educational process. Today, it is digital technologies that make it possible to improve the quality of education and the use of innovative teaching methods. In such conditions, the transformation of the educational process is also taking place: traditional methods based mainly on the transfer of knowledge are becoming a thing of the past, and they are being replaced by new ones based on the use of information, communication and gaming technologies. The modern education system every day more and more links the participants of the educational process with the virtual space and its elements. And the role of games and gaming technologies is growing more and more: they are gradually becoming one of the key elements of the educational space.

Gamification is the process of using game thinking and the dynamics of games to engage in problem-solving, turning the educational process into a game. By gamification, we mean the introduction of games, gaming techniques, and gaming practices into the socio-economic system.

The hallmark of gamification is error tolerance. Consequently, users can not be afraid of condemnation and punishment for mistakes, feel free, that is, fears of wrong actions disappear, and they are replaced by initiative and confidence. Students can independently choose options for action, which encourages their active participation and forms a sense of responsibility for their own actions.

Gamification can be considered a successful way of organizing the educational process, which, when studying the disciplines of the natural and mathematical cycle, has a certain pedagogical potential, which means that the gamification of the educational process allows you to increase the level of activity in the study of the material, the efficiency of assimilation of new knowledge and the acquisition of skills that will be basic learning more complex topics.

Today, gamification is spreading to all spheres of life at such a pace that other types of digital technologies simply cannot keep up with it. Higher education institutions, according to most experts and practitioners, are experiencing

positive effects from: distance education, personalization, gamification, interactive textbooks, learning through video games. And exactly four of this list are related to gamification. That is why the choice in the topic of the article fell on these digital technologies.

The main purpose of the article is to model the stages of using digital technologies for introducing gamification into the education system.

2. LITERATURE REVIEW

An analysis of scientific literature shows that gamification is a phenomenon of human activity that can make educational activities more manageable and planned, a way of focusing special attention on completing tasks, which will help achieve a more productive result through the use of modern digital technologies. The main features of this phenomenon, which are distinguished by almost all researchers [1-3], are: the mechanics used in computer games, applied to any other non-game type of activity, firstly, increase the motivation of the subject to pay more attention to the process of activity, and secondly, continue the interest in the task and, finally, increase the likelihood of achieving the set goals in the context of the emergence of Industry 4.0.

Yaseen et al. [4] noted that digital technologies are the future of the training system. Information technology, which allows you to transfer everything to the game system and online mode, is part of Industry 4.0, gradually covering more and more countries of the world.

Today, digital technologies are being applied [5] in the possibilities of improving the online platform for teaching professional skills. The interactivity they offer can lead to new learning methods in general.

As most scientists note [6-8], gamification should not be paramount, but rather optional. So it is quite effective for visual recognition of the achievements of the object, organization of competitions within the training course, and designing the content of the training. But they believe that in fact, in the educational process, clear learning goals, the reality of the results obtained and their possible application in life and professional activities, in addition, to important organizational changes in educational organizations and departments (support for teachers who design effective educational programs, designing high-quality classrooms, developing the information and communication infrastructure of the socio-economic system.

According to Deterding et al. [9], the key aspects of gamification are dynamics - the use of scenarios that require user attention and real-time response; mechanics - the use of scenario elements, such as virtual awards, statuses, points, virtual goods; aesthetics - creating a general gaming experience that contributes to the emotional inclusion of the user; social interaction - a wide range of techniques and digital technologies that provide interaction that is characteristic of games. We partly agree with this vision.

In the scientific literature and on the part of practitioners [10-12], opinions are also expressed regarding the caution of using gamification and the criteria for its effectiveness. For example, it is noted that the active use of badges and leaderboards in classes with adults almost always greatly intensifies competition. Yes, the spirit of struggle will encourage students to complete tasks faster and better, but if one of the participants gets a result that is very far from the

leaders of the list, then with certain settings, this person may lose heart and decide that there is no point in learning. In addition, real learning programs built on gamification should include a plan (algorithm) to achieve real learning goals and change the behavior of students.

You can know for sure, that there is enough scientific and practical literature [1-20] on the study of this topic. Various authors have their own vision of solving this problem. Here we have both modeling and the formation of matrices with mechanisms. However, technology does not stand still. Industry 4.0 is already here with us in every aspect of our lives. It is simply impossible to ignore the development of digital and information technologies. New possibilities of gamification still remain unexplored. Research in this direction should be continued.

3. METHODOLOGY

An educational institution is a socio-economic system and all its key features are inherent in it. Therefore, econometric modeling can be applied to it as a system. We believe that the introduction of gamification is a step-by-step process and it should represent something informationally and graphically. The process begins, brings certain results and in the end, has a certain effect on itself.

So, we will apply the ICAM (Integrated Computer-Aided Manufacturing) methodology, or rather one of its methods. In particular, the I-CAM DEFinition or Integrated DEFinition method. Through a graphical language, we will be able to present such a model that will be understandable to those responsible for the use of digital technologies for the implementation of gamification in the socio-economic system. The methodology is known and new. It has become a kind of heir to the SADT (Structured Analysis and Design Technique) methodology. The description of our methodology is well known and can be easily found on the Internet or Wikipedia. It is not new, and many scientists often use it [12, 13].

I-CAM DEFinition or Integrated DEFinition method is one big goal modeling methodology. This methodology includes various modeling techniques for everything possible, we have chosen the Integrated DEFinition 0 (IDEF0) modeling technique. IDEF0 - Function Modeling - methodology of functional modeling. With the help of the visual graphic language IDEF0, the system under study (namely, the integration of digital technologies into the information space of the educational process) appears to developers and analysts as a set of interrelated functions (functional blocks - in terms of IDEF0). As a rule, IDEF0 modeling is the first step in the study of any system. According to the methodology, we must establish the main goal A0 and the stages to achieve it. All its stages will be presented in the results of the study.

Of course, when we talk about modeling, we should put it into practice. A generalized vision of the model for all socio-economic systems would be a mistake. Most scientists [10-15] argue that it is impossible to carry out the so-called "universal" modeling for all systems. There are too many factors against this, starting from the individualism of the system itself and ending with its external functioning environment. We have a war on the territory of Ukraine and we cannot go to the leading educational institution in Europe and apply our model there. Therefore, the object will be V.N. Karazin Kharkiv National University. This university has gone through many ups and downs. According to his so-called "digital history", there was practically no mass application of gamification (Figure 1).
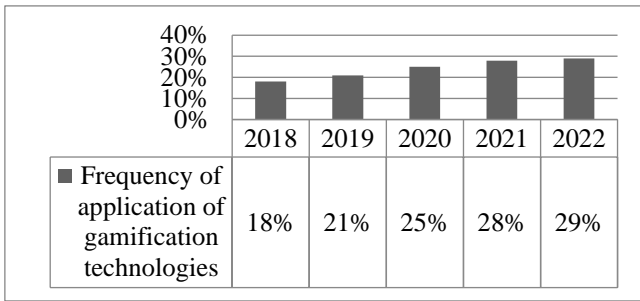
Figure 1. The share of the volume of application of gamification technologies in V.N. Karazin Kharkiv National University (developed by the authors)

We understand that there are not many examples of one socio-economic system, but this article is the first step toward the development of the above methods and possible solutions to the problem indicated in the topic. All results will be further in the text of the article.

4. RESULTS OF RESEARCH

To begin with, the main goal of the model should be formed. Let the main goal of the model be the effective use of digital technologies for introducing gamification into the information space of the educational process. Let's give this the symbol $A0$. It should be noted here that in order to achieve the so-called $A0$, there must be certain stages that will form the process (1):

$$A0=[A1;A2;A3;A4;A5;A6] \qquad (1)$$

Thus, we can use the above (1) subsets to form a hierarchy diagram for our multi-stage model (Figure 2).

The choice of all stages from A1 to A6 was made according to the experience of working at the university for which the simulation is being carried out. Discussion and coordination with other experts in the industry.

For the socio-economic system we have chosen, V.N. Karazin Kharkiv National University these will be the following stages:

A1 - The use of digital gamification technologies in learning a foreign language. Each educational institution, despite the specialty, has subjects for studying a foreign language, at least English. In the selected socio-economic system, no gamification technology for learning foreign languages is used. The Duolingo digital platform is proposed. This is an online community that provides the opportunity to learn a foreign language by self-translating websites and documents. Beginners are tasked with translating basic, simple sentences from the Internet, while experienced ones are given much more complex tasks. Duolingo provides the necessary learning and translation tools to help students understand and remember the words they encounter. While students are learning a language, they earn skill points for each completed lesson or translated content. The more tasks a player completes, the faster his level grows. The site also contains data on how long it took the user to complete the task. Wrong answers lead to the loss of points and "lives". The site tracks every completed lesson, translation, test, and practice to provide student feedback and plan future lessons and new tasks for translation.
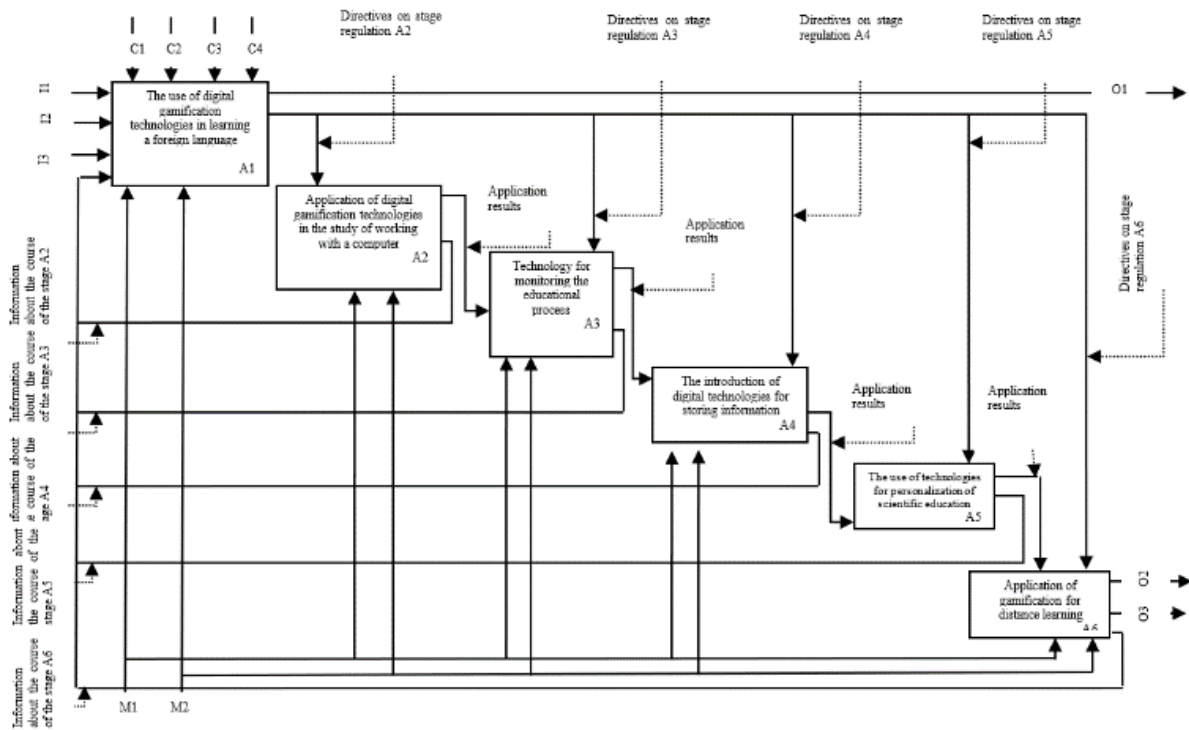
A2 - Application of digital gamification technologies in the study of working with a computer. Programmers in an educational institution are only 2% of all in the socio-economic system. Most participants in the system simply do not know how and do not know all the advantages of computer programs for work. The institution we have chosen has significant problems with "digital literacy". Offered Ribbon Hero - a game that will teach you how to use Microsoft Office, and its basic tools and tools. In the game, the user needs to solve a problem, and upon execution, he will receive achievement points. The problems are grouped into four sections: working with text, page and layout design, artistic representation, and a generalized section of quick tasks. In the first three sections, each task introduces the user to a key feature and allows the user to edit the sample document using that feature. Quick tasks do not offer specific challenges but allow you to accumulate additional points. This stage assumes the duration of the implementation within two weeks. If within two weeks there will be no results on this stage, a decision should be made on zeroing and changes in the implementation of the project.
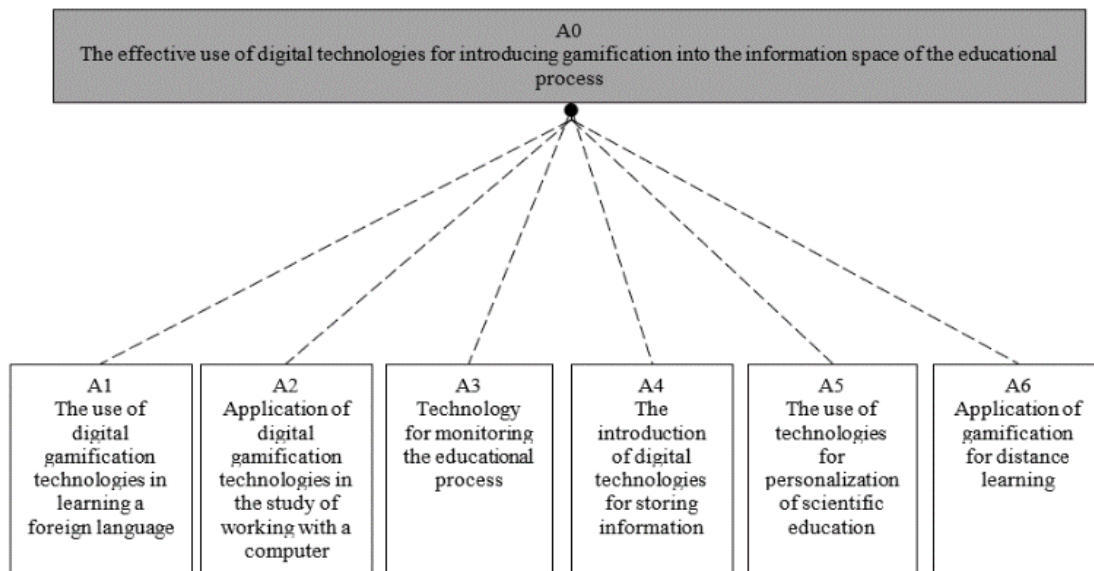
Figure 2. The hierarchy diagram for our multi-stage model (developed by the authors)
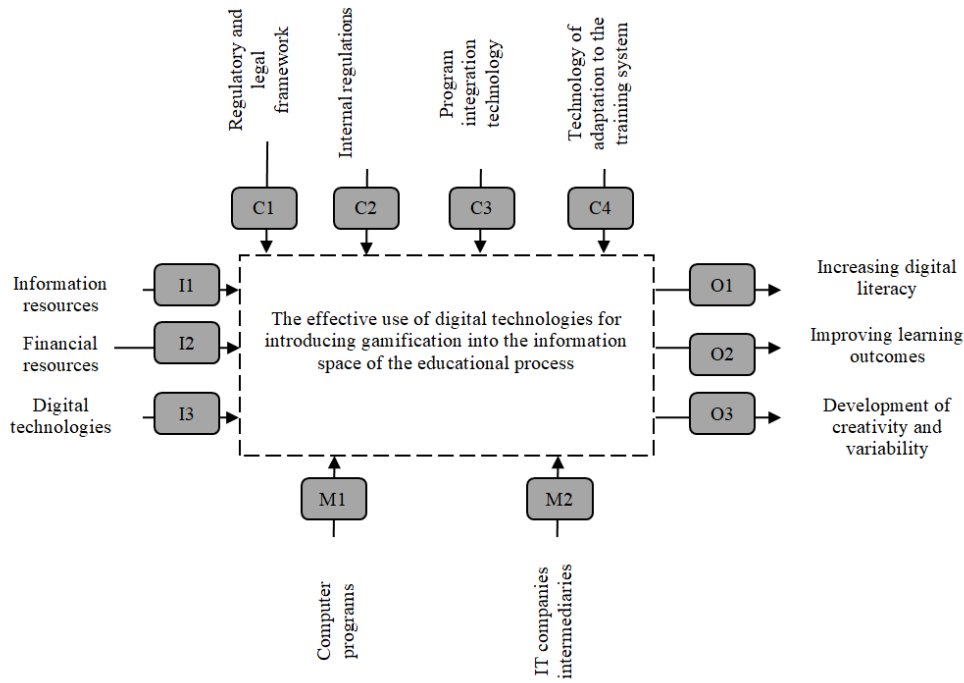
Figure 3. Diagram of model implementation elements (developed by the authors)

Figure 4. The multi-stage model of the use of digital technologies for the introduction of the gamification system into the educational process (developed by the authors)

A3 - Technology for monitoring the educational process. The Goalbook application follows. It is an online platform that helps teachers, parents, and students to track their learning progress together. Combining the features of social networks and an individualized learning program, the program makes the education process simple for both students and teachers. Students, together with teachers, form goals and task steps that need to be done in order to achieve these goals. The stage provides for two weeks of implementation for the formation of relevant information with conclusions. If there is no progress within two weeks, you should return to the adjustment of the previous stage.

A4 - The introduction of digital technologies for storing information. Brainscape is a mobile learning platform that helps students learn and most importantly memorize any kind of information. The program uses adaptive algorithms to create memory cards (these are used to memorize words, formulas, or individual information), changing the sequence of displaying cards depending on what the user knows and what causes difficulty for him. The stage provides for two weeks of implementation for the formation of relevant information with conclusions. If there is no progress within two weeks, you

should return to the adjustment of the previous stage.

A5 - The use of technologies for personalization of scientific education. We recommend using Spongelab. The technology offers a digital platform for organizing scientific work and allows you to create tools for processing scientific information. The stage provides for two weeks of implementation for the formation of relevant information with conclusions. If there is no progress within two weeks, you should return to the adjustment of the previous stage.

A6 - Application of gamification for distance learning, offered by Khanacademy. The technology allows you to create and use video courses on various subjects. Interactivity and variability have a significant impact on the learning process. Can be used in libraries or as supplementary material. The stage provides for two weeks of implementation for the formation of relevant information with conclusions. If there is no progress within two weeks, you should return to the adjustment of the previous stage.

First of all, you need to have an idea of what we achieve using digital technologies for introducing gamification in the selected socio-economic system (Figure 3).

Of course, as can be seen from Figure 3, here we have both resources and software and a number of other auxiliary elements to achieve the task. In general, when using the proposed gamification technologies in V.N. Karazin Kharkiv National University, we expect that this socio-economic system will receive the following effects: the level of digital literacy will increase; improving the efficiency of the educational process; there will be a question of development of creativity and variability.

So, the final result of the study will be the construction of the model itself (Figure 4).

Directives in the assignment model for establishing a control system for the implementation of gamification technologies. The fact is that the use of digital technologies for the introduction of gamification in the educational process is an extremely difficult task and requires an appropriate control system. Directives are formed depending on the specifics of the socio-economic system.

The results of each stage (not necessarily 100% successful) carry with it a certain set of information that must be transmitted to achieve the next stage. This is where the flexibility of the system opens up. The information required from a particular stage may differ. Here you can set the task so that the information will be minimal or maximally detailed. And of course, the stages themselves can be changed or their hierarchy of positions can be changed.

Each stage of the model has its own task and is designed to achieve certain intermediate goals. The total implementation of all stages will allow us to talk about the full range of applications of digital technologies for introducing gamification into the educational process of the socio-economic system.

To understand that the goals of each stage have been achieved, each university must set its own criteria for this, depending on the operating environment and the characteristics of the internal structure of the educational process.

It should be noted that during the simulation, all the parameters of the model and its elements were formed taking into account the fact that the educational process is based on the university and the educational culture of the European type. It is important to remember that when discussing model parameters, this should be taken into account.

5. DISCUSSIONS

Discussing the results of the study, we can note that everything was done and analyzed. There is room for growth and further consideration in this issue. We tried to approach it from a more modern point of view. Consider through the prism of a real socio-economic system (a full-fledged institution of higher education). This is just one example, but more to come. We surveyed the proposed model after a certain period of time, what is their opinion about it and how will they evaluate the improvement in the information and educational progress of students at Karazin Kharkiv National University (Figure 5).
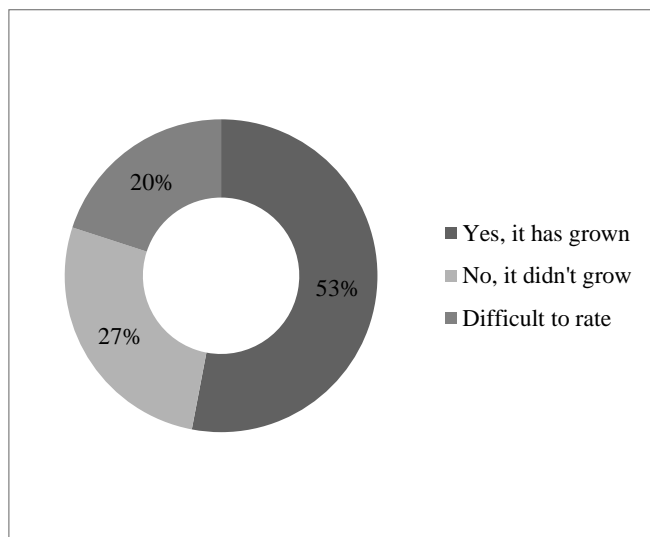
Figure 5. The results of the survey and the subject of improving the information and educational efficiency of students through the use of modern gamification technologies (developed by the authors)

The term for obtaining the results of the survey is 3 months after the application of the model. Within three months, the dynamics of the survey results did not change significantly.

Comparing our research with others, it should be noted that each scientist works as he thinks is right and we do not try to criticize other people's research results.

Some scientists in their models [13, 14] shifted the focus to modeling feedback from the use of gamification technologies. Gamification allows you to constantly provide automatic feedback. By using the various leader boards, you can be aware of your own dynamics and compare them to previously set benchmarks, or compare your own performance to that of others. Feedback is one of the most important elements of gamification because it allows users to constantly understand the quality and appropriateness of their own activities.

Other scientists [15-17] tried to summarize the very mechanism of gamification implementation. Predominantly, most of the proposed gamification mechanisms provided for the decoration of the very activity of the socio-economic system and the formation of a sense of so-called progress and a sense of satisfaction from learning and applying one's own professional skills. Like any other mechanism, it was a positive factor to leave room for the freedom to choose additional goals for you, depending on the type of application of gamification technologies. We also tried to make our model as flexible as possible and not limit it. Each stage can be changed and edited according to the requirements of a particular system.

SOME scientists [18, 19] tried to show through the prism of time how technologies have changed. The approaches used 20 years ago are becoming ineffective: learning as a simple transfer of information is perceived as a boring and uninteresting process, and gamification allows you to achieve learning goals, allowing students to play and have fun. Gamification is not just a proven way of delivering educational content, but also a time requirement that must be taken into account for the successful implementation of any e-learning course.

For example, the results of a study by Kryshtanových et al. [20] directly demonstrated that in the end, any socio-economic system burns out. And the person at its center is no exception. Digital technologies due to gamification can stop this process for a while. They bring novelty and refresh the learning process itself.

We formed a model taking into account the multi-stage nature and with the possibility of demonstrating the possibility of its information basis for making decisions on the use of gamification technologies. Our model is purely informational and systemic in nature for the user.

6. CONCLUSIONS

Summing up, I would like to note that every year the gap between the level of training of individuals and the quality of educational programs in such a socio-economic system as a higher educational institution increases. And the problem is not only in the unwillingness of students to perceive new information, its source is that they grow up and study in a different educational and social space - interactive gaming. The education system is in a crisis and, of course, all available means must be used to maintain and preserve it. The use of game methods can be the condition under which young people want to learn again. In general, digital gamification technologies are encountered almost at every step – and are not limited to modern innovative teaching methods. Wherever a game or competitive element is introduced, digital gamification technologies are used.

The main advantage of gamification is its motivational properties. First of all, it is competitive in nature, which increases the overall level of quality and speed of work. In general, the practice of using games in education has already established itself as an effective tool, because during training in the format of a game, a larger amount of information is absorbed, and it is retained in memory longer. First of all, gamification technologies should be used to form certain skills or behaviors; for greater visualization and emphasis on such actions and skills that are difficult to demonstrate using traditional methods; to captivate the participants, and create a kind of competition between them; so that the participants themselves can observe their progress.

Although we have described digital technologies throughout this article as a positive effect on education, it should be noted that they have certain limitations compared to traditional teaching methods. The traditional teaching method may not allow you to process and analyze educational information so quickly, its assimilation occurs more efficiently.

Based on the results of the analysis, a multi-stage model of the use of digital technologies for the introduction of the gamification system into the educational process for a specific socio-economic system was formed. The study has limitations and they relate to the use of one educational institution and do not take into account all the digital technologies that can be applied in accordance with the research topic. Further research requires the question of analyzing the complexity of the gamification implementation system in modern conditions and determining what negative consequences it can bring to the socio-economic system. Also, in future studies, we will select an educational institution with a high level of digital literacy for comparative analysis.

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