

FORMATION OF A DYNAMIC MODEL OF IT MAJORS USING GAMIFICATION

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ABSTRACT. Currently, gamification in education has become a full-fledged object of research. The current state of gamification allows us to consider it as an innovation that has potential in terms of didactics, organizational and methodological support of the educational process and management of educational institution as a whole. The main advantage of gamification is the possibility of modernizing the learning process, which increases students' intrinsic motivation and their involvement in the learning process.

The purpose of this article is to present a dynamic model based on the analysis of gamification models. As a theoretical contribution of gamification, we form a dynamic model of game-based learning, which aims to improve the effectiveness of learning related to five main factors (difficulty, interest, observation, imagination and choice). The dynamic model was used to teach first and second year students of the Computer Technology Faculty of Pavlodar universities (Toraighyrov University and Pavlodar Pedagogical University named after Alkey Margulan) the Python programming language using educational resources consisting of gamification elements, and the theory of educational environment design is called ARCS (attention, relevance, confidence and satisfaction) and the theoretical foundations of gamification are defined by the framework of MDA (mechanics, dynamics and aesthetics).

KEYWORDS: gamification, game-based learning, ARCS, MDA, motivation, learning process.

ГЕЙМИФИКАЦИЯ АРҚЫЛЫ ІТ МАМАНДАРДЫҢ ДИНАМИКАЛЫҚ МОДЕЛІН ҚАЛЫПТАСТЫРУ

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АҢДАТПА. Қазіргі уақытта білім беру саласындағы геймификация зерттеулердің толыққанды тақырыбына айналуда. Геймификацияның қазіргі жағдайы оны дидактика, білім беру процесін ұйымдастырушылық-әдістемелік қамтамасыз ету және жалпы білім беру мекемесін басқару тұрғысынан әлеуеті бар инновация ретінде қарастыруға мүмкіндік береді. Геймификацияның басты артықшылығы-оқу процесін жаңғырту мүмкіндігі, яғни білім алушылардың ішкі мотивациясын арттыруға және олардың оқу процесіне қатысуына ықпал етеді.

Мақаланың негізгі мақсаты-геймификация модельдерін талдау арқылы білім берудегі геймификацияның динамикалық моделін құру. Геймификацияның теориялық үлесі ретінде біз бес негізгі факторға (қиындық, қызығушылық, байқау, қиял және таңдау) байланысты оқытудың тиімділігін арттыруға бағытталған, ойынға негізделген оқытудың динамикалық моделін қалыптастырамыз. Динамикалық модель Павлодар қаласындағы жоғары университеттердің (Торайғыров университеті және Әлкей Марғұлан атындағы Павлодар педагогикалық университеті) ақпараттық технологиялар бағытында білім алатын бірінші және екінші курс студенттеріне арналған Python программалау тілін геймификация элементтерінен тұратын оқу ресурстарын үйренуде және ARCS (attention-зейін, relevance-маңыздылығы, confidence-сенімділік, satisfaction-қанағаттану) деп аталатын білім беру ортасын жобалау теориясын пайдалана отырып, геймификацияның теориялық негіздері MDA (mechanics-механика, динамика-динамика және эстетика-эстетика) қолданылды.

ТҮЙІН СӨЗДЕР: геймификация, ойынға негізделген оқыту, ARCS, MDA, мотивация, оқу процесі.

ФОРМИРОВАНИЕ ДИНАМИЧЕСКОЙ МОДЕЛИ IT-СПЕЦИАЛИСТОВ С ПОМОЩЬЮ ГЕЙМИФИКАЦИИ

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АННОТАЦИЯ. В настоящее время геймификация в сфере образования стала полноценным предметом исследования. Современное состояние геймификации позволяет рассматривать ее как инновацию, обладающую потенциалом с позиций дидактики, организационно-методического обеспечения образовательного процесса и управления образовательным учреждением в целом. Основное преимущество геймификации заключается в возможности модернизации учебного процесса, что повышает внутреннюю мотивацию учащихся и их вовлеченность в процесс обучения.

Целью данной статьи - сформировать динамическую модель путем анализа моделей геймификации. В качестве теоретического вклада геймификации мы формируем динамическую модель обучения на основе игры, которая направлена на повышение эффектив-

ности обучения, связанного с пятью основными факторами (трудность, интерес, наблюдательность, воображение и выбор). Динамическая модель применялась при изучении языка программирования Python для студентов первого и второго курсов информационных технологий вузов г. Павлодара (Торайгыров университет и Павлодарский педагогический университет имени Алкея Маргулана) с использованием учебных ресурсов, состоящих из элементов геймификации, и теории проектирования образовательной среды под названием ARCS (attention-внимание, relevance-значимость, confidence-уверенность, satisfaction-удовлетворение), а теоретические основы геймификации определяются рамками MDA (mechanics-механика, dynamics-динамика and aesthetics-эстетика)..

КЛЮЧЕВЫЕ СЛОВА: геймификация, обучение основанное на играх, ARCS, MDA, мотивация, процесс обучения.

INTRODUCTION. Gamification is one of the various learning methods aimed at increasing user engagement and motivation when performing or learning tasks [1]. Gamification involves the use of game elements, mechanics and dynamics outside the context of traditional games [2]. In addition, this author identifies three reasons why gamification can serve companies; these reasons can be easily adapted to different situations, so they will be outlined in the context of learning. The reasons for gamification success are based on three cornerstones: engagement, experimentation and results.

Domestic and foreign researchers actively study the phenomenon of gamification, including in the field of education. Despite this, the identification of the potential of gamification as a full-fledged didactic tool of the educational environment is not given due attention. This is due to the insufficient development of the theoretical basis of many studies and specific methodological recommendations for the implementation of gamification in the educational process, a unified system approach [3] and the procedure for assessing the effectiveness of gamified educational process [4]. Moreover, such recommendations are lacking both from the academic community and leading practitioners in the field of gamification.

What is the difference in the educational effectiveness of gamification of learning compared to traditional teaching methods? First, it is necessary to discuss the progress

of goal in terms of time. Achievement (skill or knowledge) can be expressed as a linear equation in terms of time or effort in traditional teaching: textbook, whiteboard, human teachers, face-to-face classroom, etc. In the general case, it may appear that the graph of academic performance initially rises and then stops rising. This suggests that traditional learning cannot maintain sustained attention and results in limited educational effectiveness [5].

Gamification has the necessary tools and potential to increase the level of emotional involvement of students in the educational process [6]. First of all, gamification components are able to involve students in the educational process, to increase cognitive motivation and interest in the discipline under study, in scientific issues reflected in the gamified educational process. Cognitive motivation should be understood as "such a state of a person that reflects the lack of necessary knowledge" [7]. The main advantage of gamification as a specific game practice is the possibility of using the same tools that create conditions for the growth of both external and internal and, in particular, cognitive motivation.

Historically, intrinsic motivation is the coolest theory of all the research that makes things, especially digital games, interesting. Thomas Malone proposed three basic characteristics of computer games: observability, interest, and imagination. After heuristically analyzing dozens of computer games, he identified these three components as his "What makes learning

fun?" [8].

i. A task is created by setting clear, defined goals for the learner. Undefined outcomes create difficulty by offering different levels of complexity, hidden information, and randomness.

ii. Interest comes in two forms: sensory and cognitive. Audio and visual effects, especially in computer games, can increase sensory interest.

iii. Malone defines imagination as a means that "creates mental images of things beyond the reach of the senses or the actual experience of the individual". It includes both human emotions and logical thought processes. A few years later, Malone and Lepper added another very important concept of a game design system, "control", to the original three features and defined all four features as "key characteristics of learning games" [9].

iiii. Control refers to the student's sense of self-determination and self-control. Components such as contingency, choice and power contribute to the function of control in the learning process.

MATERIAL AND METHODS OF RESEARCH.

The analysis of philosophical, pedagogical and psychological literature of foreign and domestic authors allowed to identify the methodological basis for the development of the idea of gamification in the framework of the ongoing research, including the change of the system of scientific approaches to the development of game activity, the formation of cultural characteristics of Game spaces, theoretical and practical features of the development of conceptual.

The study highlighted key concepts, the presentation of which helped to enter the

research space and establish the relationship between the main characteristics of gamification.

The gamification element is borrowed from the MDA framework, which is based on game design theory [10]. The MDA framework consists of three components, namely: Mechanics related to games, which describe specific components of the game at the level of data representation and algorithms; Dynamics is the behavior of a mechanic at runtime that affects player inputs and other outputs over time; Aesthetics describe the emotional reaction desired by the player when the player interacts with the game system [11].

The ARCS model includes [12] a ten-step process for designing motivation systems in work and learning. The first two steps, which are part of the general components of the analysis process, provide information about the existing state of affairs and serve as a basis for analyzing deficiencies and their causes, which is carried out in the third and fourth steps. On the basis of these analyses, a description of motivational goals and how they are to be evaluated is drawn up in step five. Two design steps follow. Step 6 is to brainstorm each motivational category to create a broad list of possible solutions. Step 7 is critical and analytical to select solutions that meet the time, resource, and other constraints of the particular situation. The last three steps involve both development and evaluation, similar to the development of any other model.

Stages of motivational design ARCS:

1. Get information about the course
2. Getting information about the audience
3. Analysis audience
4. Analyze other elements of the course
5. List the goals and assessments

Table 1. Component of framework MDA

Mechanics	Dynamics	Aesthetics
<ul style="list-style-type: none"> • Points • Levels • Problem • Virtual goods • Board leaders • Badge • Gifts and charity 	<ul style="list-style-type: none"> • Award • Status • Achievement • Self-expression • Competition • Altruism 	<ul style="list-style-type: none"> • Satisfaction • Pleasure • Envy • Respect • Connection

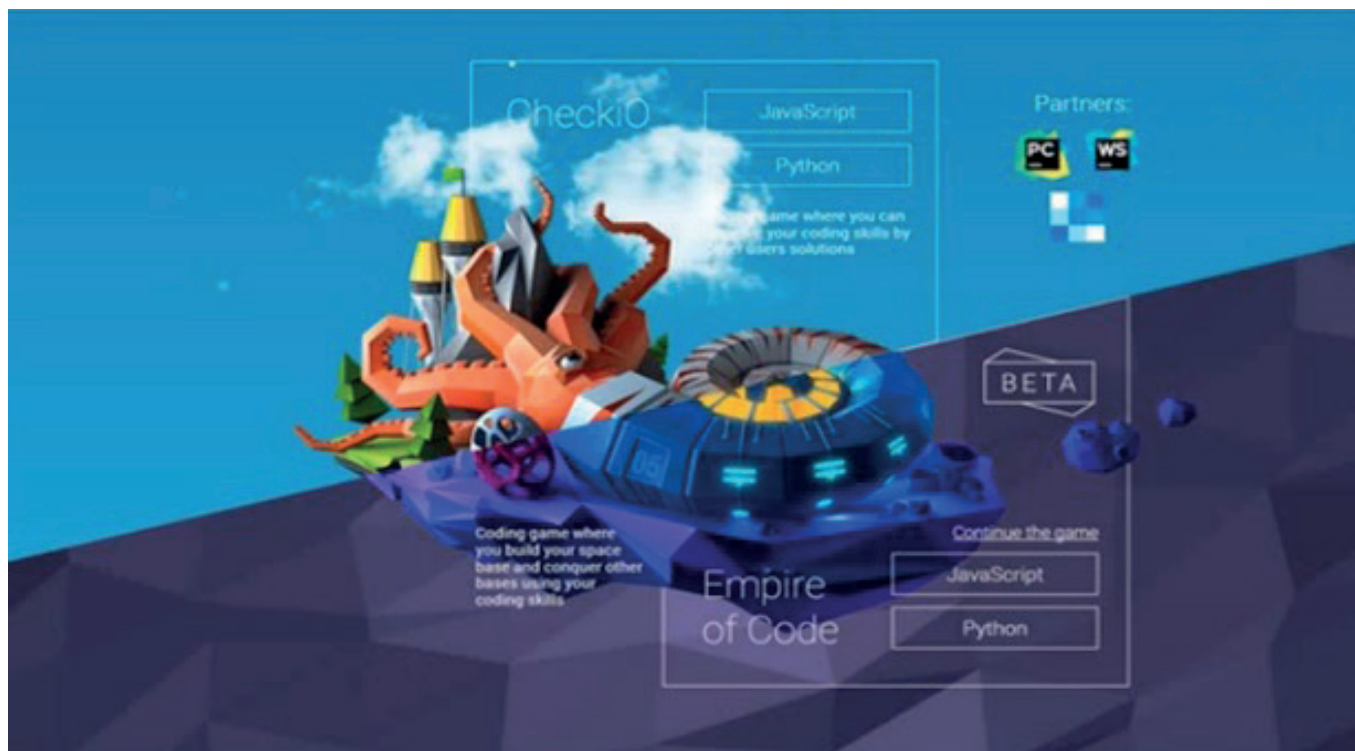


Figure 1 - Home page of the CheckiO gaming platform

6. List potential tactics
7. Selection and development tactics
8. Integration with instructions
9. Selection and development of materials
10. Rate and review

These 10 steps follow a typical problem-solving and design process, but three steps are particularly important: analyzing the audience, compiling a list of possible tactics, and selecting and developing tactics.

RESULTS AND THEIR DISCUSSION. During the study the trajectories of "Cybersecurity", "Software Engineering", "DevOps-engineering", "Web Development", "Graphics, Augmented and Virtual Reality" of students studying in the educational program 6B06104-Computer Science of Toraighyrov University, 6B01530-Computer Science of Pavlodar Pedagogical University named after Alkey Margulan, As an additional teaching tool for students of 1-2 courses studying in the direction of 6B01531-Information technologies in education, the game platform CheckiO (Figure 1) was used.

We click on the Python button on the home page and sign up through your Google account. This is a resource for learning and using the

Python programming language. Learning is offered in the form of a game in which each user must apply their knowledge to a certain extent. At the first stage Elementary is a sequence of tasks from easy to difficult (Figure 2). At the same time, the description of the task contains all the reference data for its solution. Thus, the user learns the Python programming language by examples and tries his/her own skills in parallel. In the future, it can be used to study and acquire skills in working with oupensor libraries.

Students check themselves by performing tasks, in case of incorrect performance the value of the report is not displayed, and when moving to the next stage there is a gap (Figure 3). Under the game field the number of points scored is indicated.

This game consists of platform gamified elements, that is. levels, points and leaderboards (rating tables). The use of gamification in the educational process, on the one hand, requires a lot of work related to the preparation of game elements and methods of organizing students' learning activities. However, on the other hand, the introduction of gamification

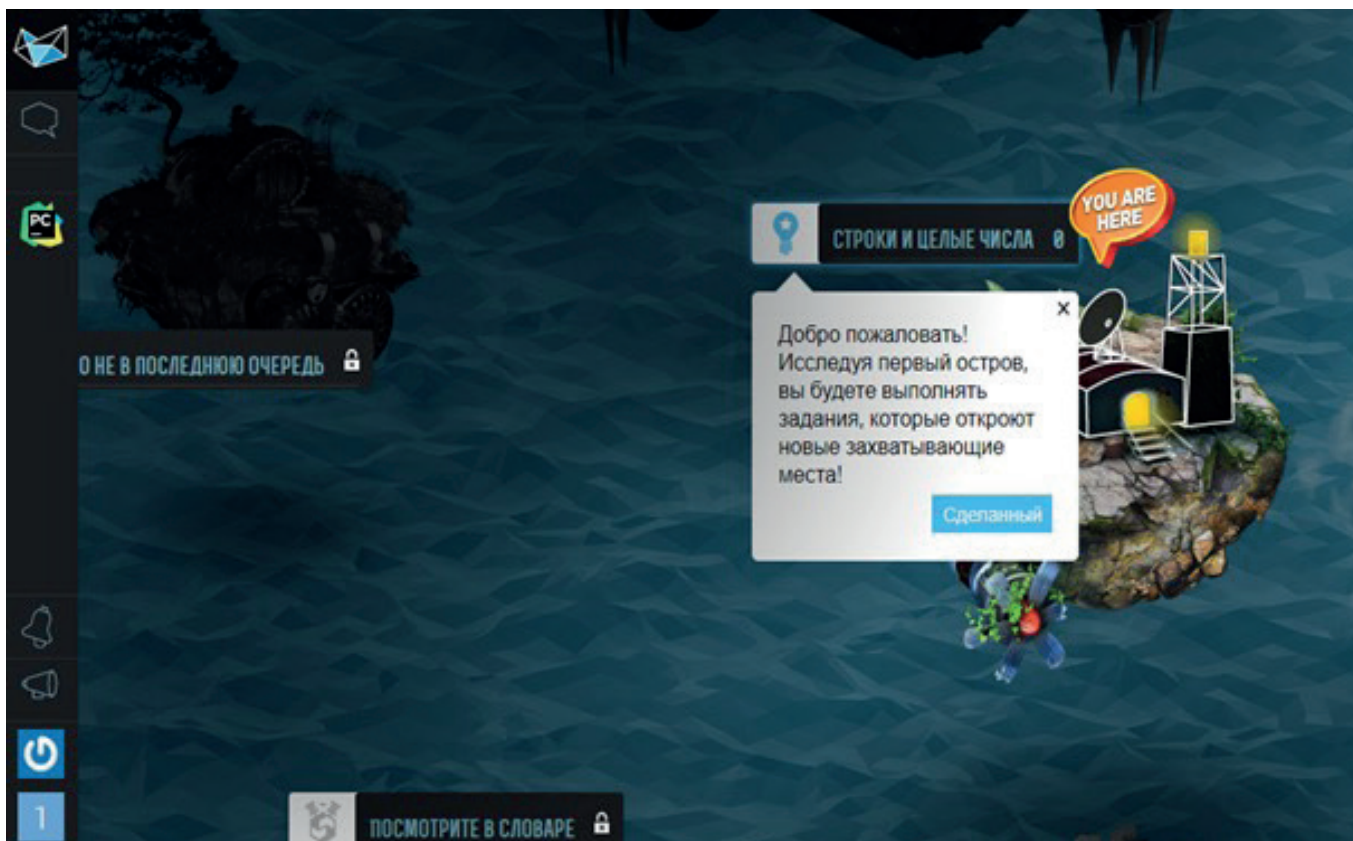


Figure 2 - The page where the task sequence is located

resources into the educational process allows to organize, evaluate and motivate the current achievements of students, to introduce game elements into the educational process, as well as to maintain a healthy spirit and competitive atmosphere.

In educational practice, the use of gamified educational resources as a process in which the most important characteristics of future activities are presented, allowing sufficient understanding of the specifics of professional activities and perspectives, can be very

significant because, firstly, learners develop personal experience in the context of the game. Secondly, mental processes (thinking, imagination, speech) are actively stimulated, which contributes to the vision of both the unified learning process and, in particular, the components of the game. Thirdly, the team spirit of the game participants is developed.

To determine the effectiveness of using gamified educational resources by students and their readiness to use them, the motivational components of learning were

Table 2. Representative sample data

Group	University	Name of the course, specialty	Number of students
Control	Toraighyrov University	6b06104 Computer Science, 1 course (Cybersecurity, Software engineering, DevOps-engineering, Web development, Graphics, augmented and virtual reality)	45
Experimental	Pavlodar Pedagogical University named after Alkey Margulan	6b01530 Computer Science, 6b01531 Information technology in education, 1-2 courses	38

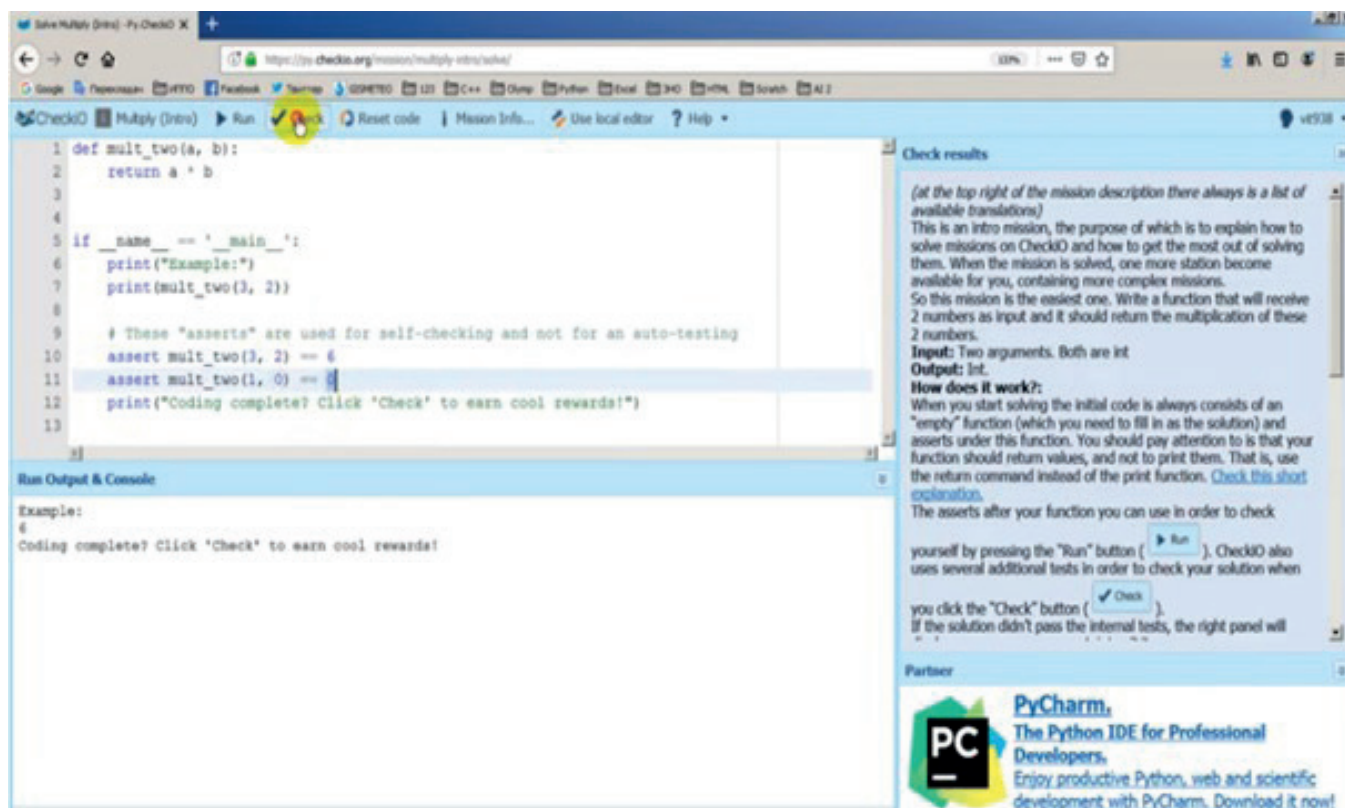


Figure 3 - Task execution page

tested. Experimental work was carried out from 2022 to 2023 on the basis of higher educational institutions of Pavlodar. It involved 83 students, 38 of them - in the experimental group (Pavlodar Pedagogical University named after Alkey Margulan), 45 students - in the control group (Toraighyrov University), the data of representative sample are shown in Table 2.

The next step of our research was to carry out the determining stage of experimental work in order to determine the level of training of students, studying in the specialty it, in the Python programming language in accordance

with the criteria and indicators. The investigated criteria and indicators are presented in Table 3.

The presence of motivation and needs in the development of knowledge, skills and abilities for the use of gamified educational resources. Test for determining the orientation to obtaining knowledge on programming using gamified educational resources, including the CheckiO gaming platform

The presence of a constant interest, self-confidence and a creative approach when performing tasks in a playful way C o n t r o l , Interview, Survey

Table 3. Determining criteria and indicators

Indications	Determination method
The presence of motivation and needs in the development of knowledge, skills and abilities for the use of gamified educational resources.	Test for determining the orientation to obtaining knowledge on programming using gamified educational resources, including the CheckiO gaming platform
The presence of a constant interest, self-confidence and a creative approach when performing tasks in a playful way	Control, Interview, Survey
Formation of the desire for self-improvement and raising the level	Scale for assessing the need for achievement

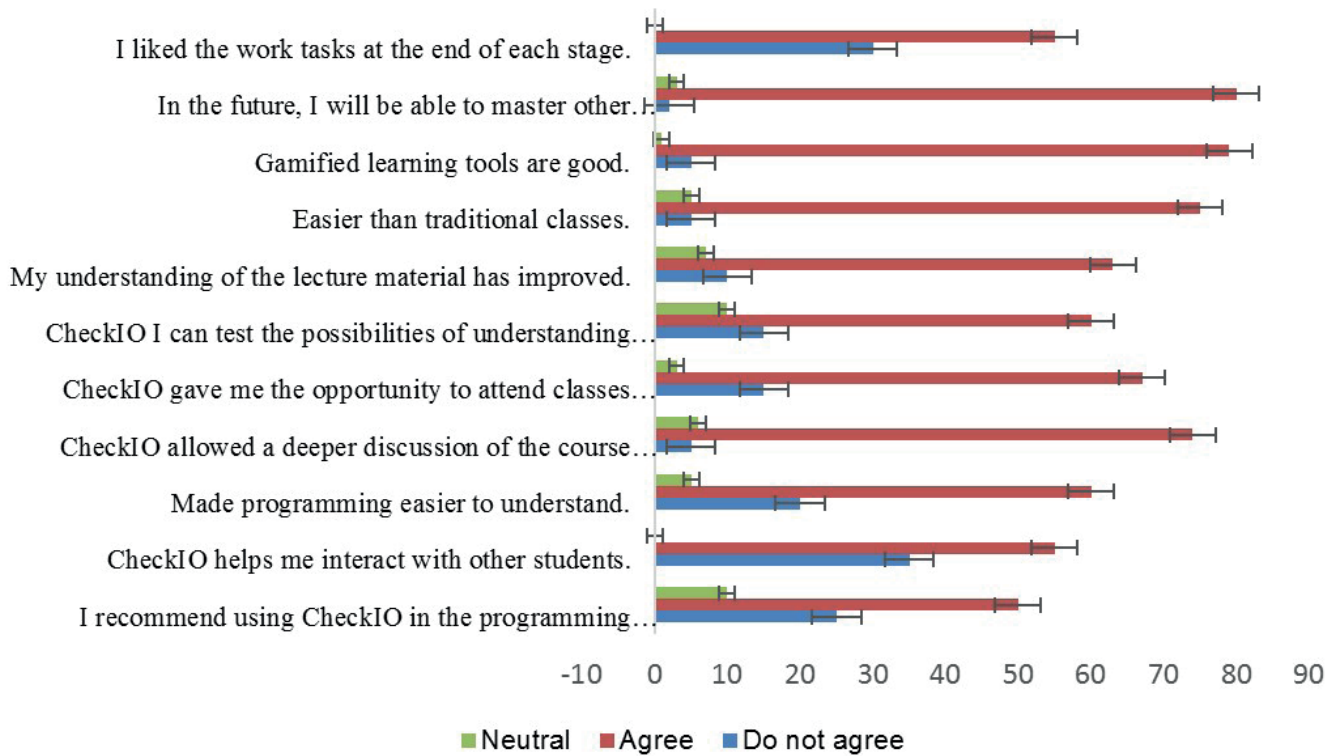


Figure 4 - Students answers to closed questions

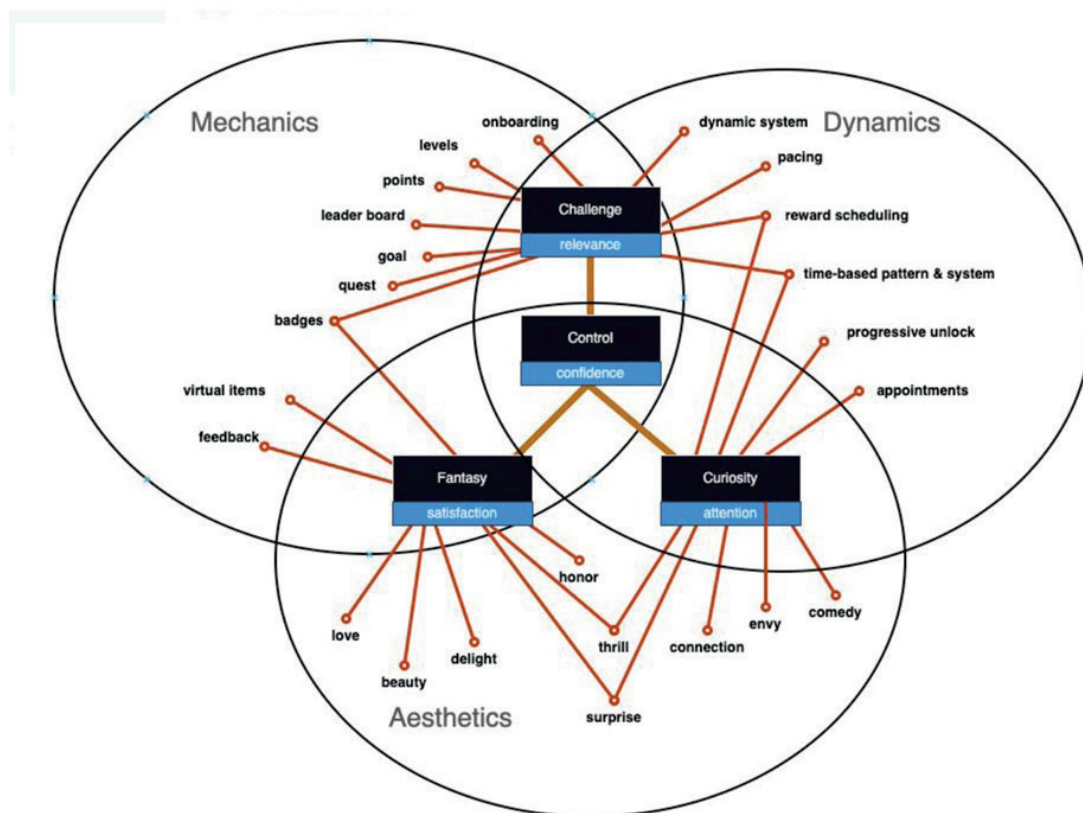


Figure 5 - Dynamic model of learning gamification

Formation of the desire for self-improvement and raising the level Scale for assessing the need for achievement

IT to diagnose the needs and motivations of students studying in the specialty in the development of knowledge, skills and abilities on the use of gamified educational resources, the first study was carried out on the use of the CheckiO gaming platform. Figure 4 shows students' answers to questions on the Likert scale. The answers consist of answers that agree, are neutral, and do not agree.

Game-based learning can be achieved through digital or non-digital games and simulations that allow learners to experience the learning process firsthand.

In conclusion, we get the following diagram, connecting all the elements with each other. As analyzed above, education associated with five main factors (difficulty, interest, observation, imagination and choice) covers all MDA and ARCS models. So, four main factors can be very effective in implementing educational gamification (Figure 5).

CONCLUSION. The motivation model was developed in response to a desire to find better ways to understand the underlying factors

that influence motivation to learn, as well as systematic methods for identifying and solving problems related to motivation to learn.

Game elements play an important role not only in education but also in numerous non-game applications on PCs, smartphones and tablets. This article has mainly hypothesized a dynamic model related to game-based learning cases. To confirm this hypothesis, we analyzed the basic elements of digital game design, intrinsic motivation theory, MDA framework and ARSC model. Hoping for broad application, we introduced the term «gamification in learning» instead of using game-based learning or learning game by applying the theoretical foundations of Game-based learning to create a dynamic model.

The dynamic model of educational effectiveness of gamification has a solid and stable educational effectiveness. Our model increases dramatically after the initial period of time when the learner adapts to the learning game process.

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