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THE INFLUENCE OF GAMIFICATION ON THE FORMATION OF THE KNOWLEDGE COMPONENT OF THE BIOLOGICAL TRAINING OF FUTURE TEACHERS

Annotation. *This article discusses the influence of gamification on the formation of the educational component in the subject training of future biology teachers in the context of digital learning. The relevance of the study is determined by the need to modernize the professional training of teaching staff in higher educational institutions. The main focus of the study is on the analysis of gamified learning opportunities as a means of improving students' learning activities and improving educational achievements. The purpose of the study was to identify the influence of gamified tasks on learning outcomes and the peculiarities of students' perception of the learning process. The empirical research work was carried out on the basis of the Abai Kazakh National Pedagogical University with the participation of 4th year students of the educational program "Biology". Students were divided into experimental and control groups and tested before and after the experiment. In addition, a survey was conducted among students. The results of testing and surveys of academic performance of students in the experimental group show that their motivation to study with academic performance was significantly higher than in the control group. The practical significance of the study lies in the possibility of introducing gamification into the educational process of pedagogical universities. The scientific value of the work is to expand empirical evidence on the role of the gamification method in the professional training of future biology teachers.*

Keywords: *gamification, biology teaching, educational component, future biology teachers, digital educational technologies, Student Achievement Test (SAT)*

Introduction

In the context of the transformation of the higher education system, it is of particular importance to improve the quality of professional training for future teachers, including biology teachers. The Concept of Education Development of the Republic of Kazakhstan emphasizes the need to update the content and teaching methods, as well as the active use of digital and interactive technologies in the educational process [1]. The training of future biology teachers involves the formation of a solid knowledge component, including the assimilation of fundamental biological concepts, processes and patterns. According to M. Bolyskanov, traditional forms of higher education do not

always provide a sufficient level of student activity and depth of knowledge acquisition, which dictates the need to switch to personality-oriented approaches supported by digital and interactive technologies [2]. This is especially relevant for biological topics that require an understanding of complex processes, their interrelationships and practical significance, such as nutrition, reproduction, growth and development and isolation. In this regard, there is a growing interest in using gamification as an innovative pedagogical method that can enhance students' learning activities and increase the effectiveness of knowledge acquisition. Gamification is considered as the introduction of game elements and mechanisms into a non-game educational context in order to increase motivation, engagement and learning outcomes of students. Historically, gamification research has evolved gradually. In the early stages, game elements were used primarily in the field of marketing and personnel management. Their main function was to increase the motivation and retention of participants. Later, gamification became an object of theoretical understanding in the academic environment. There were works in which game elements were considered not only as motivational stimuli, but also as tools for influencing the behavior and involvement of participants. The very term "gamification" was introduced in the early 2000s. However, sustained scientific interest in this phenomenon was formed only in the 2010s. During this period, gamification began to be seen as an interdisciplinary approach applicable in various social and educational contexts. A similar evolution in the understanding of gamification is reflected in the works of Kazakhstani researchers. In particular, in a number of master's degree studies, gamification is interpreted as the use of game elements outside the game in order to change behavior, increase engagement, and indirectly influence performance [3]. Modern research in the field of pedagogy and educational technologies confirms that gamification can have a positive impact on both the motivational sphere of students and their cognitive achievements, especially in a digital educational environment [4]. The context of training future biology teachers, the issue of integrating gamification into computer-technology-oriented academic disciplines is becoming particularly relevant, where it becomes possible to flexibly vary the content and forms of educational activities.

The discipline "Computer Technology and Modeling in Biology" provides favorable conditions for the introduction of gamified tasks with biological content. A discipline focused on digital technology and modeling naturally supports the use of gamification, as it allows for the use of process visualization, interactive tasks, and a fast feedback loop. This creates the conditions for designing a "gaming" experience without replacing the educational content with entertainment components.The use of digital tools, interactive tasks and game forms of learning allows not only to develop the digital competence of future teachers, but also to purposefully form their biological knowledge. Thus, gamification within the framework of this discipline can be considered as an effective

means of developing the knowledge component of the professional training of future biology teachers. The relevance of this study is also due to the need to obtain empirical data confirming the effectiveness of gamification in a real educational process in a pedagogical university. A comparative analysis of the learning outcomes of students in the experimental and control groups allows us to objectively assess the impact of gamification on the level of assimilation of biological knowledge and determine its pedagogical potential.

The novelty of this study is to provide empirical data on the impact of gamification on the knowledge component of the training of future biology teachers in the framework of an integrative ICT-oriented course ("Computer technology and modeling in Biology"). Unlike studies that focus primarily on motivation, this study puts learning outcomes into practice by using a standardized test of student academic achievement before graduation (SAT) with an assessment of the magnitude of the effect. In addition, the document proposes and tests a mission/station-based training program related to specific digital tools (Google Docs, Excel-based modeling, and artificial intelligence feedback) that allows for the creation of evaluable learning artifacts. The results obtained expand the evidence base of gamification as a cognitive-supportive pedagogical method in teacher education.

The purpose of this study is to study the influence of gamification on the formation of the knowledge component of the biological training of future teachers in the context of the use of computer learning technologies. In accordance with the stated purpose, the following research questions were formulated in the study:

– does the use of gamification have an impact on the level of formation of the knowledge component in biology among future teachers in the process of studying educational topics of biological content?

– are there differences in the dynamics of boundary control results between the students of the experimental and control groups after the introduction of gamified learning tasks?

– how do future biology teachers assess the impact of gamification on their learning motivation, interest and involvement in the process of studying biological material?

In accordance with the research questions, the following hypotheses were put forward:

– the introduction of gamification into the educational process contributes to a statistically significant increase in the level of formation of the knowledge component in biology among students of the experimental group compared with the control group;

– the growth rate of frontier control results among students who studied using gamification is higher than that of students who studied in traditional learning environments;

– the use of gamified learning tasks has a positive effect on educational motivation, interest and involvement of future biology teachers in the educational process.

Despite the growing number of publications, the problem of the influence of gamification on the formation of subject biological knowledge remains insufficiently studied, especially in pedagogical universities. One of the most authoritative sources in the field of gamification is the meta-analysis by M. Sailer and L. Homner, based on empirical research published in the journals Scopus and Web of Science [5]. The authors have shown that gamification has a statistically significant positive effect not only on motivation, but also on cognitive learning outcomes. At the same time, it is emphasized that a steady increase in knowledge is observed in cases when game elements are integrated into the content of an academic discipline. These conclusions are developed in a later meta-analysis by M. Li, S. Ma, and W. Lu, where the authors found that gamification has a more pronounced effect in natural sciences than in humanities [6]. This is due to the need for active processing of information, visualization and repetition of the material, which is especially typical for biological courses. Linking words, gamification is considered not only as a motivational tool, but also as a means of cognitive support for learning.

Directly in the field of biology education, T. Pathiraja and A. Ranasinghe have made a significant contribution by introducing a gamified team quiz into biology courses [7]. The authors recorded a statistically significant improvement in test results and an increase in student engagement. The synthesis of the considered studies allows us to conclude that gamification is an effective pedagogical method for the development of the knowledge component, provided it is purposefully integrated into the subject content. At the same time, there remains a shortage of empirical research focused on the training of future biology teachers in pedagogical universities, which determines the scientific novelty and practical significance of this study.

Materials and methods

The study was conducted using a quasi-experimental design with experimental and control groups according to the pre-test post-test scheme. This design made it possible to assess the impact of gamification on the formation of the knowledge component of the biological training of future teachers in a real educational process.

The experiment consisted of three stages:

– the ascertaining stage;

– formative stage;

– the control stage.

The study involved 84 4th-year students of the Kazakh National Pedagogical University named after Abai, studying in the field of Biology. The research was conducted in the 7th semester in the framework of the discipline “Computer Technology and Modeling in Biology” (5 credits). The educational process strictly followed the calendar plan, where gamified missions on the topics of “Nutrition”, “Reproduction”, “Growth and

development" and "Isolation" were integrated into seminars and workshops. Software tools and platforms approved in the syllabus of the discipline were used to implement the tasks. The final year students were included in the study, since by this stage they have completed the development of the core of biological disciplines and have a well-formed subject base. This allows us to assess the impact of gamification not on the "initial acquaintance", but on the quality of assimilation and structuring of knowledge. The final year is a critical stage in the professionalization of a future teacher, when teaching methods are correlated with subsequent pedagogical practice. The participants were divided into experimental and control group. Both the experimental and control groups studied with the same teacher during the semester. The total number of academic hours, program content, learning objectives, and control tasks were the same in both groups. The only variable changed was the learning format: the experimental group performed biological modules in a task-based game format, while the control group studied the same content using traditional teaching methods (lecture-seminar format without game mechanics). This design allowed us to identify the gamification factor as the main independent variable.

In this study, gamification was considered not as the use of ready-made digital games, but as a pedagogical strategy for designing the educational process based on the integration of game mechanics into educational tasks with biological content. This approach corresponds to modern concepts of gamification as a way of organizing learning, in which game elements are used to enhance learning activity and assimilation of content, rather than to replace learning goals. As an illustrative example, the topic "Nutrition" was implemented using a mission-based gamified format. The mission included four stations: "Functions of nutrients", focused on the classification and comparison of biological concepts; "Energy balance", involving the solution of computational problems; "Metabolic pathways", aimed at building cause-and-effect relationships; "Scenarios of diets", implemented in the format of a case analysis.

Using the example of gamified tasks in Table 1, the total mission implementation time was 90 minutes of classroom work and 45 minutes of ISWT, which is confirmed by logs of student activity in Google Docs. Points were awarded for completing tasks at each station in accordance with predefined criteria, including accuracy, reasonableness of answers, and quality of teamwork. Upon completion of work at the station, the teams received feedback and the opportunity to move on to the next stage. Each mission included several tasks, arranged according to the principle of complexity and requiring the active application of biological knowledge. The transition to the next stage was possible only after completing the previous task, which ensured logical coherence and a gradual deepening of the content. The classes were based on the principle of station training.

Table 1 – Structural and functional model of the gamified mission “Nutrition”

Stage (Station)	Didactic Purpose (Syllabus)	Game Mechanics (Gamification)	Technology Stack (IT Tools)	Generated result (Evidence)
Station 1. Functions of nutrients	Classification of macro- and micronutrients, analysis of their role in metabolism.	Time Attack / Collaboration. Team search and sorting of data for speed.	Google Docs, Cloud storage.	A joint register of cross-referenced nutrients.
Station 2. Energy balance	Solving computational problems; mastering biological modeling methods.	Leveling / Accuracy. The transition to the next level is possible only with accurate calculation of BMR and TDEE.	MS Excel, Calculators	Mathematical model of the character's energy consumption (screenshot of the calculation table).
Station 3. Metabolic pathways	Construction of causal relationships of biochemical cycles.	Puzzle / Feedback. Build a “metabolism map” with instant error checking.	AI assistant (Gemini / ChatGPT, Notebooklm AI) for verification of circuit logic	A flowchart of metabolism generated and adjusted by the student.
Station 4. Scenarios of diets	Case analysis and application of knowledge in non-standard situations.	Storytelling / Role-playing. The role of the “digital nutritionist” in solving the patient’s problems.	Google Docs, Databases of scientific literature.	An analytical conclusion (case report) uploaded to the LMS.

To assess the results of completing tasks, a scoring system was used, which allows you to record educational achievements in digital form. In the course of gamified learning, the teacher served as a designer of the learning environment and moderator of the educational process. His functions included designing assignments, organizing learning activities, advising students and ensuring a pedagogical balance between play and educational content. The teacher did not directly interfere with the tasks, but provided support in case of difficulties and monitored compliance with learning objectives. Linking words, gamification in this study acted as a means of activating cognitive activity and forming a knowledge component in biology, rather than as an end in itself.

To assess the level of formation of the knowledge component, the results of the border control, which was conducted twice, before and after experiment. The test was developed based on the content of the discipline module and included tasks for reproducing key concepts, understanding cause-and-effect relationships, and applying knowledge

in learning situations. The equivalence of the «before/after» forms was ensured by the coincidence of thematic coverage and levels of complexity with different formulations. The substantive validity was confirmed by the expert assessment of teachers of biological disciplines. The maximum possible score was 100, while the actual results did not exceed 95 points.

To study the educational motivation, interest and involvement of the students of the experimental group, a questionnaire was used after completing the formative stage of the experiment. The survey was implemented using Google Forms and included 20 statements. The survey was conducted on the basis of an adapted questionnaire developed based on the provisions of the theory of self-determination by E. Deci and R. Ryan, as well as modern research on the gamification of learning. The assessment was carried out on a five-point Likert scale (from 1 – "totally disagree" to 5 – "totally agree"). The reliability of the scales is assessed by the internal consistency coefficient a > 0.70.

Descriptive and logical statistical data were used to analyze the results of border control. The averages and standard deviations were calculated. To compare the SAT results before and after the experiment, a paired Student's t-test was applied in each group, while the independent Student's t-test was used to compare the experimental and control groups based on the results after testing. The practical significance of the differences was assessed using the magnitude of the effect (Cohen coefficient). The level of statistical significance was set at $p < 0.05$. In the tables, N indicates the number of participants, M is the average value, SD is the standard deviation, and Δ is the change in indicators between the results of the pre-test and the post-test.

To test the hypotheses of the study, the Student's t-test was applied. The paired t-test was used to compare the SAT results before and after testing in the experimental and control groups (Tables 1 and 2). An independent t-test was applied to compare the results after testing between the experimental and control groups (Table 4). The practical significance of the observed differences was assessed using the effect value (Cohen's d). Statistical significance was established at the level of $p < 0.05$.

Results and discussion

This section presents the results of a pedagogical experiment based on conducting pre- and post-test testing in experimental and control groups. Changes in learning outcomes were assessed by comparing SAT scores before and after the intervention in each group, as well as by comparing post-test scores between groups. The significance of the observed differences was verified using the Student's t-test, and their practical significance was assessed by calculating the magnitude of the effect (Cohen's d). This approach allowed us to substantiate the conclusion about the higher learning outcomes demonstrated by the students of the experimental group. The Student Performance Test (SAT) consisted of 30 assignments covering the key topics of the module. The test included three types of tasks

such as multiple choice questions assessing factual knowledge (10 points), short-answer questions requiring explanations of biological processes (10 points), and applied tasks involving the interpretation of biological scenarios (10 points). The maximum possible score was 100 points. For each correct answer with multiple choice answers, 2 points were awarded; tasks with short answers and problem tasks were evaluated according to a predefined category (0-5 points per task) based on completeness, scientific accuracy and logical justification.

The answers of the students of the experimental group obtained during the survey aimed at determining the level of educational motivation, interest in the lesson and the degree of participation in the educational process were considered. Descriptive statistics methods were used to generalize and present the data obtained, and standard statistical comparison methods were used to identify differences between indicators.

Table 2 – Descriptive statistics of SAT results before the experiment

Group	N	Min	Max	M	SD
Experimental group	42	67	90	82,4	5,8
Control group	42	68	89	81,9	6,1

Table 2 shows the SAT results before the introduction of gamified learning. The range of values, averages, and standard deviations for the experimental and control groups are presented.

Table 3 – Descriptive statistics of SAT results after the experiment

Group	N	Min	Max	M	SD
Experimental group	42	75	95	91,5	4,9
Control group	42	74	94	87,6	5,6

Table 3 shows the SAT results after completing the formative stage of the experiment, including the range of values, averages, and standard deviations in both groups.

Table 4 – Dynamics of SAT results

Group	M (Pre)	M (Post)	Δ (score)	Δ (%)
Experimental group	82,4	91,5	+9,1	11%
Control group	81,9	87,6	+5,7	7%

Table 4 shows the changes in the average values of SAT scores before and after the experiment in the experimental and control groups, including the increase in points and percentages.

To demonstrate the structure and cognitive requirements of the assessment tool, an example of the SAT application is provided. “Explain how increasing carbohydrate intake affects ATP production through glycolysis and oxidative phosphorylation.” In the control group, students usually described glycolysis and ATP production as separate processes, without directly linking substrate availability and regulatory mechanisms. On the contrary, the students from the experimental group were more likely to demonstrate complex thinking, clearly linking carbohydrate intake, glycolytic flow, NADH production and ATP synthesis in mitochondria.

Table 5 – Checking the statistical significance of the differences (t-test, p) and the effect size

Comparison	Criterion	t	Df	P	Cohen’s d
Experimental group: Pre and Post test	paired t-test	9,87	41	<0,001	1,45
Control group: Pre and Post test	paired t-test	6,12	41	<0,01	0,89
Experimental and Control groups: Post tests	independent t-test	3,84	82	<0,001	0,84

Table 5 contains the results of a statistical analysis of differences within and between groups after the experiment. The Cohen’s d effect size is also presented as an indicator of the practical significance of the differences.

Table 6 – The results of the survey of students in the experimental group (Likert 1-5)

Indicator of statements	Number	M	SD
Educational motivation	4	4,25	0,58
Interest in biological topics	4	4,32	0,61
Involvement in the learning process	4	4,41	0,55
Understanding the learning material	4	4,36	0,60

Table 6 shows the generalized results of a survey of students in the experimental group on key indicators of motivational and cognitive perception of gamified learning. The questionnaire consisted of 20 statements grouped into four subscales: motivation to learn, interest in biological topics, involvement in the learning process, and perceived understanding of the material (4 points in each subscale).

The sample included the following items:

– “Game tasks have increased my interest in biological topics.”

– “The task-based format has helped me to better understand cause-and-effect relationships in biological systems.”

– “Teamwork has increased my involvement in the learning process.”

The high level of understanding and engagement recorded during the survey (M = 4.36 and 4.41, respectively) is objectively confirmed by the quality of digital artifacts obtained during gamified missions. For example, due to the cognitive support provided by artificial intelligence-enabled tools at the Metabolic Pathways station, students have developed structured conceptual models as you can see in Figure 1.

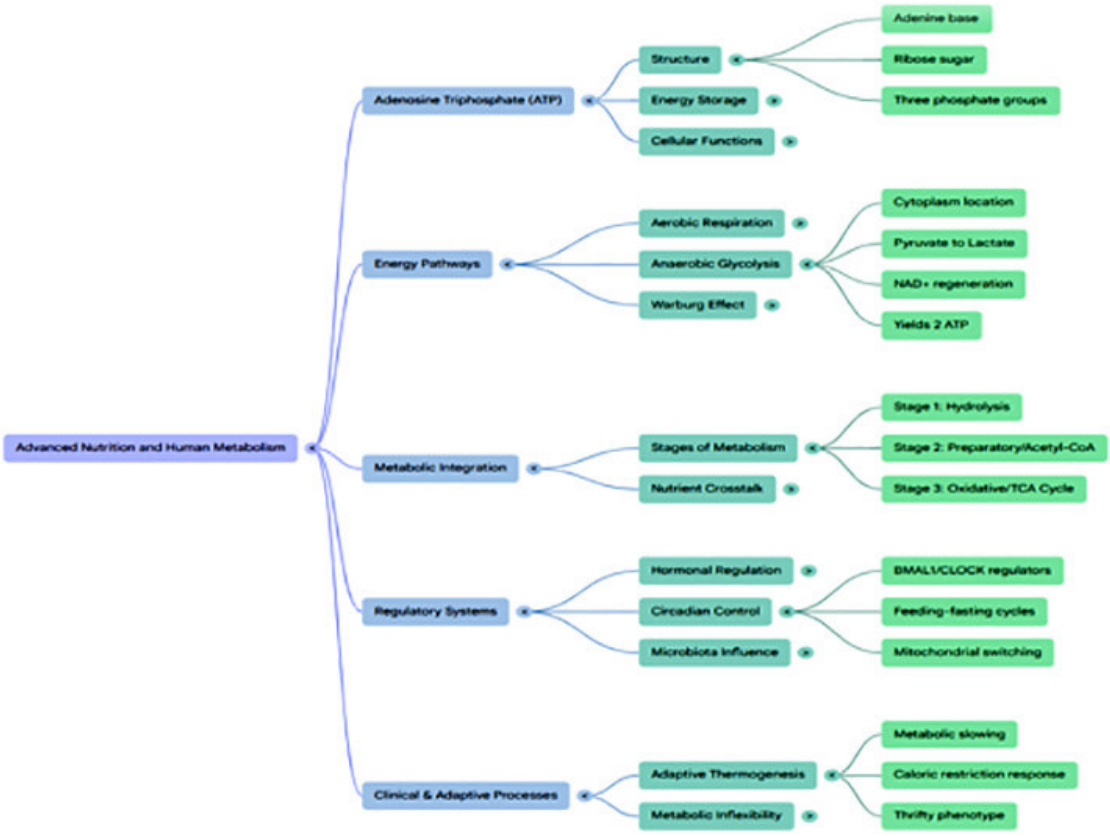

Figure 1 – Digital mental map of «Advanced Nutrition and human Metabolism» created by a group of students using the NotebookLM AI platform

The students demonstrated the ability to establish causal relationships between nutrient intake and ATP production, as well as to identify regulatory mechanisms that affect the efficiency of metabolism. Such a structured representation of biological processes indicates not only the acquisition of factual knowledge, but also the development of a systemic and integrative understanding.

The purpose of this study was to assess the impact of gamification on the formation of the knowledge component of the biological training of future teachers. The results

showed a positive trend in academic achievement in both groups, while the increase in the experimental group was more pronounced. In particular, the average Student Achievement Test (SAT) score in the experimental group increased by 11% (from 82.4 to 91.5 points), while in the control group the increase was 7% (from 81.9 to 87.6 points). In addition, an intergroup comparison of the results after the experiment revealed statistically significant differences, and the size of the effect (Cohen's d) indicates the practical significance of the implemented pedagogical impact. These results suggest that gamification can be an effective tool for developing the knowledge component in biological education, especially when integrated into a digital educational environment.

The observed dynamics in the control group seems to be expected and can be explained by a natural learning effect. Throughout the module, students of both groups worked with the same biological content (nutrition, reproduction, growth and development, isolation), which involves the consistent accumulation of knowledge, repetition of terminology and consolidation of key concepts. Such dynamics are often recorded in studies using the pre-test and post-test design, where the growth of indicators reflects a normal learning trajectory. The higher growth rate in the experimental group indicates the presence of an additional impact factor associated with the use of a gamified learning format. To explain the more pronounced increase in the experimental group, it is important to consider the gamification mechanisms that were involved in the study. Gamification in this case was not limited to the use of a "ready-made game", but was a pedagogical strategy for designing training sessions, including level progression, a scoring system, team interaction, competitive elements and immediate feedback. According to a meta-analysis by M, Sailer and L. Homner, it is precisely such mechanics (feedback, progression, goals, social interaction) that are most likely to influence not only motivation, but also cognitive outcomes [5]. The authors emphasize that gamification is effective primarily when game elements support learning goals and provide cognitive activity, rather than acting as an external "decoration". In our study, game mechanics were integrated into tasks aimed at updating biological concepts and understanding processes, which enhances the explanatory power of the results.

One of the possible mechanisms for improving SAT scores in the experimental group is increased repetition and active retrieval practice, which is often provided by gamified formats. One of the possible mechanisms for improving SAT scores in the experimental group is increased repetition and active retrieval practice, which is often provided by gamified formats. The role of immediate feedback, which is an important component of gamified learning, should also be considered. In the traditional educational process, feedback is often delayed, which reduces the possibility of quick error correction [8]. In a gamified environment, students receive information about the correctness of a decision immediately, which improves the quality of self-regulation and contributes to a

more accurate consolidation of knowledge [9]. Gamification in the experimental group included collaboration, role allocation, and joint problem solving, which could contribute to a deeper discussion of the material and the development of argumentation. A meta-analysis by M. Li, S. Ma and W. Lu indicates that in natural science disciplines, group interaction combined with game mechanics can enhance cognitive outcomes through active knowledge sharing and collaborative reflection [6]. In our study, this logic is confirmed by the fact that the increase in the experimental group was not only statistically significant, but also exceeded the increase in the control group.

The results of the survey are also consistent with the SAT data and allow us to clarify the psychological mechanisms of influence. According to the survey results, the students of the experimental group demonstrated high average scores in motivation, interest in biological topics, engagement, understanding of the material and positive perception of gamification. Although the survey is not a direct measure of academic success, it suggests that gamification created a more favorable motivational background, which, combined with cognitive activity, could affect final academic achievements. A gamified score and level system enhance a sense of competence, teamwork supports social inclusion, and the ability to choose a task strategy can enhance a sense of autonomy [10]. Thus, the survey results complement the test data and allow us to consider the gamification effect as complex – both motivational and cognitive. The data obtained confirm that gamification is applicable not only as a method of increasing interest, but also as a tool for developing the knowledge component in the biological education of future teachers.

The value of this research lies in the fact that gamification is understood not as the use of ready-made digital games, but as a pedagogical strategy for developing curricula that integrate game mechanics into domain-specific learning tasks. This approach makes it possible to align gamification with educational goals and cognitive learning outcomes, rather than with entertainment goals. By providing an empirically proven task-based biology learning model, the study demonstrates how gamification can promote both knowledge acquisition and student engagement in the digital learning process.

Despite the convincing results, the study has a number of limitations that should be taken into account when interpreting the conclusions. Firstly, the sample is limited to one university and one course of study, which may reduce the generalizability of the results to other contexts. Secondly, the experiment covered one training module and a limited set of biological topics; perhaps, with a longer intervention, the dynamics might have been different. Thirdly, the SAT forms of the test were equivalent in terms of domains and complexity, but not identical, which is standard practice, but could potentially affect the accuracy of the pre/post comparison. Fourthly, the survey was conducted only in the experimental group, which does not allow direct comparison of perception and motivational changes between the groups. Finally, the study did not analyze the long-term effect, so it

is impossible to conclude that the effect persists over time. Nevertheless, these limitations do not negate the significance of the results obtained and their practical potential. The study demonstrates that gamification, implemented as a pedagogical design, is able to enhance the formation of a knowledge component in future biology teachers in the context of digital learning. The practical value lies in the fact that the proposed gamification implementation model can be scaled and adapted to various biological sections, as well as integrated into other disciplines of professional teacher training. Further research may be aimed at expanding the sample, comparing different types of gamified mechanics, assessing the stability of the effect, and including additional methods to better understand which components of gamification have the greatest impact on learning outcomes.

Conclusion

The present study was aimed at assessing the impact of gamification on the formation of the knowledge component of the biological training of future teachers in the context of digital learning. The relevance of the work is due to the need to increase the effectiveness of teachers' professional training and the introduction of innovative approaches that ensure not only the growth of students' motivation, but also an increase in the quality of subject knowledge in biology. The results of the Student Achievement Test (SAT) showed positive dynamics in both groups, but the increase in the experimental group was more pronounced: 11% versus 7% in the control group. An intergroup comparison of the final indicators revealed statistically significant differences in favor of the experimental group, which confirms the effectiveness of gamified learning for the development of the knowledge component. Additionally, a survey of students in the experimental group recorded high levels of motivation, interest, engagement, and positive perception of gamification (M = 4.25-4.48), which allows us to consider the effects of gamification as complex, affecting both the cognitive and motivational spheres. The practical significance of the research lies in the fact that the proposed gamification model, based on missions, level progression, a point system, teamwork and immediate feedback can be applied in pedagogical universities and adapted to selected areas of biology under comparable instructional conditions. The results should be interpreted taking into account the limitations: the study was conducted in one university, covered one module, and the survey was performed only in the experimental group. The prospects for further research are related to expanding the sample, increasing the duration of the intervention, and studying the stability of the effect over time.

Contribution of the authors:

A. Azhibekova – contributed to the conceptualization and design of the study, conducted pedagogical intervention, collected empirical data (student performance test and questionnaire), conducted statistical analysis and prepared the original manuscript.

R. Izbassarova – led the research process, contributed to the methodological basis and interpretation of the results, conducted a critical revision of the manuscript and approved the final version for publication.

L. Abdullah – contributed to the development of the methodological design of the study and provided expert advice on the implementation of gamification strategies aimed at developing components of students' biological knowledge.

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Болашақ мұғалімдердің биологиялық даярлығындағы білімдік компоненттің қалыптасуына геймификацияның ықпалы

Аннотация. Бұл мақалада цифрлық оқыту контекстінде болашақ биология мұғалімдерін пәндік даярлауда білім беру компонентінің қалыптасуына геймификацияның әсері қарастырылады. Зерттеудің өзектілігі жоғары оқу орындарында профессорлық-оқытушылық құрамның кәсіби дайындығын жаңғырту қажеттілігімен анықталады. Зерттеудің негізгі бағыты студенттердің оқу іс-әрекетімен жетістіктерін жақсарту құралы ретінде геймификацияланған оқыту мүмкіндіктерін талдауға бағытталған. Зерттеудің мақсаты геймификацияланған тапсырмалардың оқу нәтижелеріне әсерін және оқушылардың оқу процесін қабылдау ерекшеліктерін анықтау болды. Эмпирикалық зерттеу жұмысы Абай атындағы қазақ Ұлттық Педагогикалық Университетінің базасында «Биология» білім беру бағдарламасының 4-курс студенттерінің қатысуымен жүргізілді. Студенттер эксперименттік және бақылау топтарына бөлініп, экспериментке дейінгі және кейінгі тестілеуден

өтті. Сонымен қатар, студенттердің арасында сауалнама жүргізілді. Эксперименттік топтағы студенттердің оқу үлгерімін тестілеу мен сауалнамалардың нәтижелері олардың оқу үлгерімімен оқуға деген мотивацияларының бақылау тобына қарағанда әлде қайда жоғары болғанын көрсетеді. Зерттеудің практикалық маңыздылығы педагогикалық университеттердің оқу процесіне геймификацияны енгізу мүмкіндігінде жатыр. Жұмыстың ғылыми құндылығы болашақ биология мұғалімдерін кәсіби даярлаудағы геймификация әдісінің рөлі туралы эмпирикалық дәлелдерді кеңейту болып табылады.

Кілтті сөздер: геймификация,биологияны оқыту, білімдік компонент, болашақ биология мұғалімдері, цифрлық білім беру технологиялары, Student Achievement Test (SAT)

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Влияние геймификации на формирование знаниевого компонента биологической подготовки будущих учителей

Аннотация. В данной статье рассматривается влияние геймификации на формирование знаниевого компонента в предметной подготовке будущих учителей биологии в контексте цифрового обучения. Актуальность исследования обусловлена необходимостью модернизации профессиональной подготовки профессорско-преподавательского состава в вузах. Основное внимание в исследовании уделяется анализу возможностей геймифицированного обучения как средства улучшения учебной деятельности и улучшения учебных достижений обучающихся. Целью исследования было выявить влияние геймифицированных заданий на результаты обучения и особенности восприятия обучающимися учебного процесса. Эмпирическое исследование проводилось на базе Казахского национального педагогического университета имени Абая с участием студентов 4 курса образовательной программы «Биология». Студенты были разделены на экспериментальные и контрольные группы и прошли тестирование до и после эксперимента. Кроме того, среди студентов был проведен опрос. Результаты тестов и опросов успеваемости студентов экспериментальной группы показывают, где их мотивация к учебе с успеваемостью была выше, чем в контрольной группе. Практическая значимость исследования заключается в возможности внедрения геймификации в учебный процесс педагогических вузов. Научная ценность работы заключается в расширении эмпирических данных о роли метода геймификации в профессиональной подготовке будущих учителей биологии.

Ключевые слова: геймификация, преподавание биологии, знаниевый компонент,, будущие учителя биологии, цифровые образовательные технологии, Student Achievement Test (SAT).

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