Professional and pedagogical training of future students of higher education with elements of gamification

Formación profesional y pedagógica de futuros estudiantes de educación superior con elementos de gamificación

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Abstract

In particular, in order to comprehensively provide applicants with the necessary didactic and developmental materials, to create a functional educational space, it is advisable to use gamification as a promising method to improve the educational process. This paper reviews research publications reflecting the degree of effectiveness and functional possibilities of game mechanics application in the educational environment. It has been established that the application of game mechanics has a particularly effective effect on

career guidance processes. The augmented reality technology contributes to the learning material assimilation, and the game learning environment allows future students to realize their creative potential.

Keywords: pre-university training, gamification, game-based learning.

Resumen

En particular, con el fin de proporcionar de forma integral a los aspirantes los materiales didácticos y de desarrollo necesarios, para crear un espacio educativo funcional, es aconsejable utilizar la gamificación como un método prometedor para mejorar el proceso educativo. En este trabajo se revisan las publicaciones de investigación que reflejan el grado de eficacia y las posibilidades funcionales de la aplicación de la mecánica del juego en el entorno educativo. Al mismo tiempo, la aplicación de la mecánica del juego tiene un efecto especialmente eficaz en los procesos de orientación profesional. La tecnología de realidad aumentada contribuye a la asimilación del material de aprendizaje, y el entorno de aprendizaje del juego ofrece a los futuros estudiantes la oportunidad de desarrollar su potencial creativo.

Palabras clave: formación preuniversitaria, gamificación, entorno educativo.

1. Introduction

Gamification in professional pedagogical training is a method of significantly expanding the functionality of this process. Preparation of future applicants for higher education is a complex task that confronts higher education professionals. In the context of this stage of professional development of the latter, it is necessary to create a qualitatively new environment, which will provide applicants with the necessary skills, and moreover, the formation of a new style of thinking and learning, which is necessary for them in the future. Content-based training within higher education involves professionally-oriented learning activities, which are quite different from the usual educational strategies of secondary school (Anastasiadis, Lampropoulos & Siakas, 2018). Accordingly, the transition phase is an important component of ensuring the proper quality of professional training. We can notice that gamification in this context is an auxiliary resource that expands the interventions of specialists in this direction. In particular, gamification can help to create a unified system of methods that will meet the goals of university preparation and combine the content of the material provided to applicants.

Currently, the implementation of game-based mechanics in the learning environment is widespread, which is due to the need to find options for solving educational challenges facing the participants of educational interaction in a new social context. Most such challenges and constraints are due to the socio-economic and political transformations of recent years. We can observe significant changes in didactic practice caused by quarantine restrictions due to the epidemiological situation caused by the spread of

COVID-19 (Teräs, Suoranta, Teräs & Curcher, 2020; Daniel, 2020; Pérez-Calderón, Prieto-Ballester & Miguel-Barrado, 2021). Based on the experience of this period, we can talk about the feasibility of digitalization of the educational process. The use of information and communication technologies in higher education has significant advantages, but it is necessary to consider the need for systemic innovation in education, given the sensitivity of students' academic performance to a number of factors that are influenced in this case. The way of systemic innovation is analyzed in the theoretical treatment of the problem, given the wide representation in the research sources. On the contrary, we can note that the creation of a single model that meets the needs of educators in different sociocultural contexts is impossible, given the characteristic differences of educational strategies. Accordingly, the proposed model requires refinement in each particular case of application.

At the same time, an urgent task for specialists in this sector is the development of comprehensive educational projects aimed specifically at applicants. In this case, it is necessary to integrate such fundamental components of professional and pedagogical training as assimilation of educational material, development of multi-context skills (in particular learning skills), adaptation to a new social and simultaneously learning environment, mastering digital literacy. A separate component is to ensure the principles of lifelong learning underlying this stage of professional training (Guerreiro-Santalla, Bellas & Duro, 2020). An attempt to solve this problem is embodied in the empirical stage of this work. The development of professional-pedagogical training program for future higher education applicants involves taking into account the above categories and conducting pilot studies.

2. Theoretical Framework

The currently available research works summarizing the experience of researchers of the twentieth century on the effectiveness of game technologies application in the process of students' training reveal this issue within the framework of a comprehensive approach. In particular, the cataloging and categorization of publications in this area gives us an opportunity to give certain conclusions regarding the appropriateness of such an intervention in the training of future applicants for higher education. Yes, gamification is predominantly used as a method of increasing students' motivation to perform academic tasks (Putz, Hofbauer & Treiblmaier, 2020). Techniques focused on tracking students' progress and learning achievements are widespread. The leading motive of the latter application is a modification of quantitative indicators of the educational process.

Turning to the question about the feasibility of this method of educational process innovation, it is necessary to take into account the results of relevant meta-analyses and literature reviews on the topic. Thus, it was found that research works aimed at evaluating the effectiveness of the application of these techniques are predominantly characterized by a positive orientation (Majuri, Koivisto & Hamari, 2018). The predominant design in these works is quasi-experimental and experimental plans. According to the results,

gamification promotes academic success, motivation of students to fulfill academic plans (Manzano-León et al., 2021).

We can notice an insufficient representation of gamification methods in pedagogical practice, which promote the qualitative study of educational material, in-depth study of individual academic topics. In this case, specialists of higher education institutions more often turn to traditional technologies that correspond to the existing strategies. It is necessary to research and, in particular, to implement new variations of gamification embodiment in educational tradition, to solve the problem of comprehensive improvement of the learning process, which will include not only the increase in rating success and curriculum implementation but also substantive creative processing of key topics in each discipline (Kim, Song, Lockee & Burton, 2018). In particular, a promising direction is the implementation of gamification technology in the field of research papers, which is often an integral part of the professional training of higher education applicants.

It is noteworthy that gamification has pronounced demographic and psychosocial dynamics. At this stage of topic processing, there is evidence of differences in the level of learning effectiveness of students of different genders under the conditions of game component implementation in the learning environment. Moreover, the type of game intervention introduced is significant. So, classical game mechanics has a more pronounced influence on male students' performance (in particular, control of success and competition), for groups of female students, it is reasonable to apply techniques aimed at social components (cooperation, recognition). Personality dispositions are also significant, modifying the measure of gamification's impact on student success (Denden et al., 2021). The use of gamification techniques in different student communities requires a preliminary assessment of the feasibility of such an intervention and a prediction of the resulting effect. In this context, the use of LMS systems is appropriate as having a perspective in assessing the learning progress of significant groups of students without the need for additional assessment and testing (Riestra-González, del Puerto Paule-Ruíz & Ortin, 2021).

It is noteworthy that gamification is closely related to the digitalization of education. Due to the amount of preparation of educational material by educators, the use of off-the-shelf digital platforms for gamification interventions is a pronounced trend in current practice. Existing templates and digital environments simplify the process of retranslation of educational material without the need to create the latest didactic developments, which in particular is of great importance in the context of the crisis conditions of today. Simplification of the process of transformation of the information array for students' assimilation provides more space for implementation of tangential teaching and educational tasks within the framework of professional and pedagogical training. In fact, it may be noted that the proliferation of game mechanics in the educational tradition is a direct consequence of the introduction of ICT into the learning process (Saleem, Noori & Ozdamli, 2022). Separately, the spread of augmented and virtual environment technologies should be noted. The latter, in particular, have significant potential for

application in the traditional learning paradigm. Currently, researchers have established that AR- and VR-technologies can be helpful in implementing STEM education principles (Tsekhmister, Kotyk, Matviienko, Rudenko & Ilchuk, 2021). At the same time, they serve as additional material for solving applied and visual learning tasks. For a broader treatment of the presented topic, it was decided to take this category into account when collecting empirical material.

The research developments indicate significant changes in teachers' self-perception of their own digital literacy, which reflects the social transformations of recent years. For example, students rate their own instrumental abilities quite highly, while at the same time they rate the critical processing of information arrays offered by the ICT environment quite low. The issue of the moral and reflective components of this process also remains open. Pedagogical workers are faced with the task of mastering the students' skills in transferring their own skills of interaction with the digital environment to the learning space (Toma, Diaconu & Popescu, 2021). Thus, the problem of systemic transformation accompanying the gamification of the educational process is also relevant. The introduction of game mechanics requires substantive justification of their use in the system of higher education, which is limited to STEM-education modeling and is not presented in the scientific discourse of Ukrainian space (Järvis, Tambovceva & Virovere, 2021). Nevertheless, it should be noted that gamification so far has an additional meaning in relation to the educational model of modernity (Prokopenko, 2021). At this stage of the development of educational traditions, the digital resource does not act as a full-fledged replacement but serves more as a space to maintain the proper level of quality of educational services provided in crisis conditions. Thus, we remain within the methodological dilemma, since the situation of wide implementation of the latest educational technologies makes it impossible to develop a full-fledged model of this process in time, while the applied dimension of this problem is realized and provides the functionality of education in the world. The continuation of research activities in this direction will likely contribute to solving the existing problems of digitalization of education and the search for new tools to improve the educational process, in which most countries exist. Deepening the process of gamification, in particular, in our opinion, allows us to form a new vision of the integrated application of innovative technologies (Monroy García, Llamas-Salguero, Fernández-Sánchez & Carrión del Campo, 2020).

3. Methodology

The presented research work is based on the method of formative experiment. A program of professional and pedagogical training for future higher education students was developed, which corresponds to the basic principles identified in the literature review. A short-term program was chosen, designed to be delivered in weekly three-day intensives over a period of one month. Each intensive, lasting an average of 5 hours, includes a separate theoretical block for students to work through, presented in different didactic techniques. In particular, the general program includes separate game mechanics, augmented environment technologies, and game-based learning environment. The program involves 425 high school students who are planning to enter higher education

institutions this year. The formative experiment was implemented based on educational institutions of different regions of Ukraine, which makes it possible to evaluate the effectiveness of these interventions in the conditions of a heterogeneous socio-psychological, demographic and educational base of future students. In particular, the program involved students of Zhytomyr City Gymnasium №3 (Zhytomyr), Ternopil Secondary School №11 (Ternopil), Samchyky Secondary School №11 (Samchyky, Khmelnytsky region), Bagachan Secondary School № 1 (Velyka Bagachka, Poltava region) and Rivne Secondary School №20 (Rivne). The content of the proposed program can be provided by the authors upon request. Now we present the plan-program of this cycle of intensives, which highlights the applied teaching techniques integrated into the process of training future students (Table 1).

Table 1.

Program of professional and pedagogical training of applicants with elements of gamification

Thematic training modules (the length of each module varies depending on the needs of the group)	Learning technologies used		
	Group 1 (control)	Group 2 (exp.)	Group 3 (exp.).
Module 1: Routine assessment of students' knowledge, skills, and abilities. Learning style	Knowledge testing method, workshop, instructional discussion	Knowledge test method (Quizziz)	Knowledge test method (quest system)
Module 2. Diagnosis and development of students' creative skills. Divergence	Group and individual visual learning	Game-based learning environment (role play)	Game design (Classtime)
Module 3. Vocational guidance. Motivation. The idea of "related work" by H. Skovoroda	Model of the situation of emotional and moral experience	Learning discussion (progress line)	Role play (narrative, avatars)
Module 4. Multi-contextual skills, soft-skills. Digital Literacy	Learning discussion, individual work	Cognitive game (Quizziz)	Game-based learning environment (Classcraft)
Module 5. The concept of lifelong learning. Mastering the educational model of higher education.	The ready-made knowledge method	The method of ready knowledge, case analysis	Role Playing (Narrative, Scores)
Module 6. Self-education. Development of the skills of independent learning	Case analysis, ready-made knowledge method	Learning discussion, independent work	Game Learning Environment (Classcraft)
Module 7. A healthy level of competition in educational activities. Testing	Frontal questioning, graphic work	Business game (narrative, points)	Business game (Kahoot)
Module 8. Preparing to pass the MST and NMT. Mastering the educational material	Quizzes, workshops	Flashcards, cognitive game (Quizziz)	AR technology (Clayerboks)

Authors' development

Since the classes were conducted in the online format, taking into account the current situation in the country and the territorial dispersion of the respondents, the subjects were distributed into groups: the first training group was implemented in the traditional educational model (without the use of the above-mentioned technologies), the training model for the second and third training groups is presented above. It should be noted that during the first session a diagnosis of the educational capabilities of applicants, a socio-psychological assessment were carried out and information on gender, age, and demographic features of established study groups was collected. To measure the above characteristics, training tests used to prepare for the NMT were applied, in addition, a psychological survey according to the model proposed by Kostruba (2018) was conducted to assess the socio-psychological features of the formation of students of different specialties. In this case, we take into account a number of key aspects of the psychological profile of future higher education applicants, which is presented in the next section of the presented work.

Note that it was decided to use digital resources to implement game components, as we consider the process of gamification as a possible resource to solve the methodological crisis of digitalization of our time. Thus, the proposed program for the training of the second training group used the Quizziz platform (https://quizizz.com), providing the possibility to track progress throughout the training program, as well as to evaluate the effectiveness of virtual currency technology. For the third training group, it was decided to choose several different ICT platforms, which would provide the opportunity to evaluate the effectiveness of different types of interventions. In particular, we used Classcraft learning and game environment (https://www.classcraft.com), a resource for team games, and designing Classtime (https://www.classtime.com/ru), an application for AR visualizations of geometric objects. Cleverbooks (https://www.cleverbooks.eu) and Kahoot (https://kahoot.com), a common resource for competitive testing in the Ukrainian educational tradition. In Table 2 we will provide details on the applied technologies and their functional significance according to the taxonomy developed by Toda et al., (2019).

Table 2.
Functional significance of the gamification techniques used in this program

Technology	Performance Components	Environmental Components	Social Components
Cognitive Game (Quizziz)	Progress, scores	Economics, choice	Puzzles, competitions
Business Game (Kahoot)	Progress, Statistics	Choice, time	Puzzles, competitions
AR Technology (Clayerboks)	Achievement	Choices	Cooperation
Game Environment (Classcraft)	Progress, Statistics, Levels	Economy, choice, chance	Reputation
Game Design (Classtime)	Getting there	Choice, time	Cooperation, narrative.
Role Play	Achievement	Choice, time, economy, chance	Reputation, cooperation,

			competition, social pressure, narrative, puzzles
Learning Discussion	Progress	Choice	Narrative
Business Game	Progress, scores	Choice	Narrative
Quest System	Achievement	Economy, Choice	Narrative, competition, cooperation

Developed from Toda et al., 2019

Accordingly, we can talk about the broader functionality of game mechanics in the direction of multi-context skills development in future higher education applicants, which contributes to the overall preparation for further professional development (Kalogiannakis, Papadakis & Zourmpakis, 2021). In particular, role-playing game mechanics is the most functional, contributing to the development of soft-skills, as well as the quest-system, which is effective for processing learning material. Preliminarily it can be noted that the use of digital resources often causes the creation of a new barrier in the interaction of teachers, which prevents the establishment of interpersonal contacts. Accordingly, it is necessary to take into account this aspect in planning the curriculum.

At each stage of the above-presented professional-pedagogical training program for applicants, a group discussion was held to identify the obstacles and limitations caused by the chosen form of educational interaction. Accordingly, the results of group conversations were analyzed using quantitative methods and corresponding generalizations are given below. Let us also note that at the end of the preparatory program a final test was conducted two weeks after the last session. Based on the results of the testing, the effectiveness of the implementation of these interventions was determined. Mathematical and statistical analysis was carried out using R Studio software, the following methods of quantitative analysis were embodied: testing of the hypothesis of equality of mean values of two dependent samples by Wilcoxon criterion, two independent samples by Student's t-criterion and one-factor dispersion analysis (ANOVA).

4. Results and Discussion

According to the results of preliminary and final diagnostics, we managed to establish characteristic regularities reflecting the degree of efficiency of game mechanics influence on the learning material and formation of multi-contextual skills by future students. In particular, we can speak about the correspondence of this innovation to the tasks of professional-pedagogical training of the latter. The corresponding results of mathematical and statistical analysis are presented in the extended visualization in figure 1.
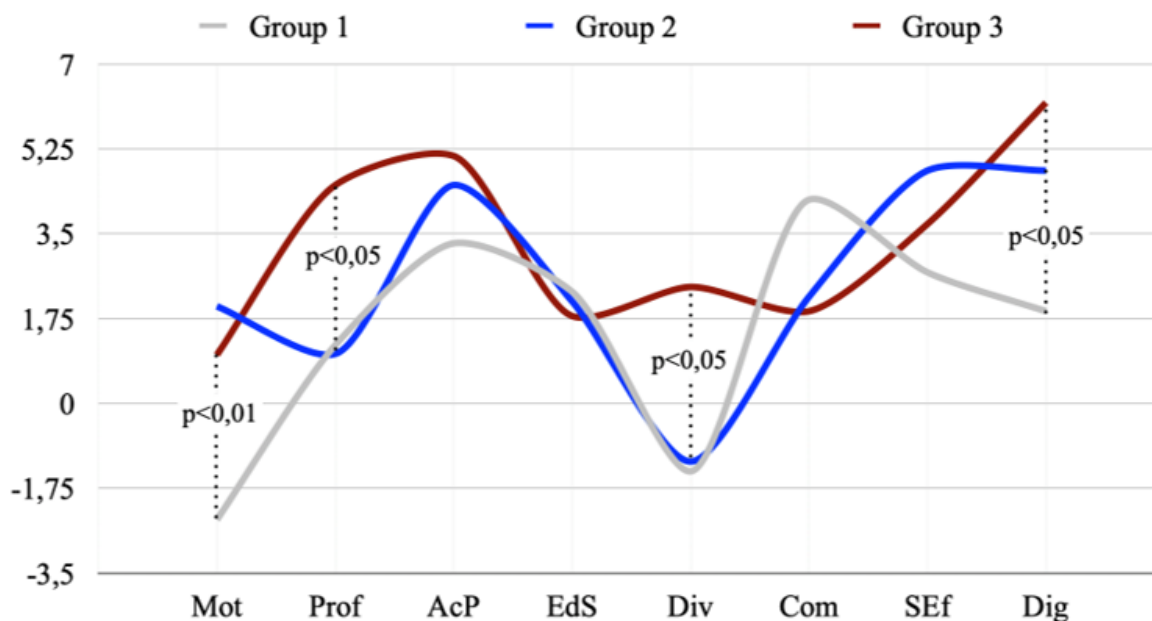
Figure 1. Visualization of statistically significant differences in the diagnostic results of the studied groups before and after the training program

The diagram shows a statistically significant difference in the test results of each of the training groups at the beginning of the training program and the end. The corresponding indicators are labeled as follows: Mot - learning motivation index, PrS - professional self-determination, AcP - academic achievement, EdS - learning skills, Div - divergent thinking, Com - communication skills, SEf - self-efficacy, Dig - digital literacy. In accordance with the results obtained, it can be noted that the use of game technology is effective with regard to such characteristics of future students as learning motivation (p<0.01), professional self-determination, divergent thinking, and digital literacy (p<0.05). Let us also note that according to the results of the one-factor analysis of variance it was determined that to a greater extent the dynamics is traced on these indicators in group 3, which indicates the effectiveness of the selected methods (in particular, the use of game learning environment, conducting role-playing games and game design). Complementing the results obtained, we present below the generalized results of the discussion with the respondents of the implemented educational techniques (Table 3).

Table 3.
Results of applicants' assessment of the gamification of the training process

Technology	Evaluation [1; 10]	Advantages	Limitations
Cognitive Game (Quizziz)	7,2	Assimilation of material, knowledge control	Lack of interactive aspect
Business Game (Kahoot)	5,1	Competition,	Time constraints, competition
AR Technology (Clayerboks)	8,9	knowledge control	Sectoral limitations
Game Environment (Classcraft)	7,0	Visibility, interactivity	Gameplay, lack of communication
Game Design (Classtime)	8,1	Relevance, increase in motivation	Insufficiency of the interface
Role Play	9,5	Self-realization, independence	Requires skills from the teacher, exhaustion
Learning Discussion	4,1	The plot, inclusion in the process, motivation	Prior training, low motivation
Business Game	2,3	Processing of the material	Complexity, prior training
Quest System	7,1	Mastering practical skills	The need to perform tasks

Authors' development

According to the applicants' assessments, it can be noted that role-playing game mechanics and AR-technologies are most easily perceived, while the business game and tutorial discussion approximating the traditional form of educational interaction are evaluated sharply negatively. At the same time, we note that students most often emphasize such disadvantages of gamification systems as: time limitations, lack of interactive components, and communication. Accordingly, we can conclude that it is necessary to introduce technologies that will provide direct interaction with the teacher and other participants in the learning process. Gamification, given the grades, should perform a sensemaking role and give learning a new connotation, which will stimulate students to independent cognitive activity. At the same time, we repeatedly face significant limitations: the need for long-term training of teachers, the development of methodological materials and programs that meet the current requirements of the educational institution, and the needs of teachers. Currently, we can note that the best option is the use of hybrid systems that modify the process of assessment and applied learning, as well as the development of narrative designs that can be used for a wide range of educational programs.

In conclusion, we note that according to the learning outcomes of the respondents, depending on their demographic and psychosocial characteristics, we can provide predictive conclusions. The results of the presented analysis allow us to take this aspect into account when developing training programs for applicants in each study group, taking into account its specificity. In particular, for future male students it is more effective to introduce game mechanics relying on the productive component (rating, progress,

achievements, and scores), while for women social games are more effective (p<0.05). No characteristic patterns of age, socioeconomic and regional differences among applicants have been established. Accordingly, we can talk about the probability of developing a unified national program of professional and pedagogical training of future applicants for higher education. According to the results of the analysis of the psychoemotional and psychosocial profile, we can note that the level of social adaptation does not play an important role in the context of involvement in game mechanics. Thus, gamification can serve as a basis for the modernization of inclusive education as well as a resource for students' socialization. Basic personality dispositions are an important factor in this direction: introverted students are less inclined to engage in game interaction with productive components, preferring environmental and social (p<0.005). Neuroticism is a suppressive factor, which makes it impossible for future students to fully realize their creative potential (p<0.05). In addition, the openness of experience has the strongest effect on the effectiveness of such interventions (p<0.005). Consequently, preliminary psychodiagnostics of the study group is advisable in order to develop the most productive program.

5. Conclusions

The introduction of game mechanics in the learning process is an innovative method to improve the latter, which allows not only to increase students' motivation but also solves urgent methodological problems of higher education. In particular, the proliferation of ICTs in educational practice requires specialists to be able to adapt to the new context of educational interaction in a systematic way. Gamification may serve as an important resource in this context. In addition, the task of ensuring lifelong learning, which requires the development of a state-of-the-art program of professional-pedagogical training for future higher education applicants, is relevant. To innovate this program, it is advisable to use game methods in the learning environment, taking into account the need to solve a set of tasks that a specialist faces under time and financial resource constraints.

The idea of combining game mechanics and a learning-game environment taking into account the possibility of independent learning of future students without the need to provide direct interaction with the teacher has a significant perspective. Digitalized learning games serve as an important auxiliary resource for learning material assimilation, while social games (role-playing, business, and game design) contribute to the multi-contextual skills of applicants. In addition, it is advisable to use AR-technologies for practical classes, which contributes to the assimilation of the material by future students. Gamification increases the level of motivation for learning, improves the dynamics of career guidance processes.

In practice, the specialists of this direction should take into account the peculiarities of the training group, in which the implementation of game methods is planned. In particular, it is necessary to take into account the gender and age peculiarities of the group, the personal dispositions of students, and their educational motives. The system approach to

the implementation of educational innovations provides the most possible effective influence within the set task.

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