# Personal Competence Formation in Education: The Effectiveness of the Development and Use of Gamified Learning Based on the Metaverse

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***Abstract*—This research aims to evaluate the effectiveness of the educational method in the formation of student personal competence. The study also identifies differences in perception between students from megacities and regions of China and Russia. The authors analysed the students' experience and knowledge in the field of gamification in the metaverse, as well as their perception of the metaverse as an educational tool. Accordingly, the research method is a survey based on the questionnaire "The Effectiveness of Using Virtual Video Metaverse-Based Games in Education" developed by the authors. The results of the study showed that more than half of the students rated the method of using virtual video games in the educational process as effective (45%) or very effective (35%). A correlational analysis and linear regression were conducted to assess the relationship between students' satisfaction levels with the use of virtual video games in education and their perception of the effectiveness of this teaching method. Data were analyzed using a standard significance level of $p < 0.05$ to determine statistical significance. A high positive correlation was found between students' satisfaction levels and their perception of the effectiveness of using virtual video games in education. The study also revealed that by using gamified learning in the educational process, students develop a variety of skills and gain new knowledge (46%). The results of this study suggest a high potential for the use of gamified learning (video games) in modern education. It is crucial to understand this potential and differences in perception between students from different regions to develop more effective educational programs based on socio-economic factors and increasingly available educational resources. The findings also necessitate further efforts in developing strategies to deal with barriers and limitations. There is an urgent need to optimize the use of metaverses in education according to local socio-cultural characteristics.**

***Keywords*—gamified learning, gamification, immersive education, metaverse, video games, virtual reality**

## I. Introduction

One of the most significant areas in the field of modern education is immersive learning in the metaverse [1]. The metaverse is a human-made virtual space, which combines elements of a virtual and real environment [2]. Immersive education, in turn, provides students with unique educational opportunities using virtual and augmented reality technologies [3]. A key characteristic of the metaverse is its capability to create three-dimensional scenarios and educational materials, allowing students to perceive and understand educational content more deeply. This feature opens up new perspectives for learning, such as interaction with data in three-dimensional space, and a more lively educational environment [4, 5]. Immersive education in the metaverse provides students with the opportunity to use their own avatars or virtual characters for deeper and more natural interaction with educational content [6]. This opportunity creates conditions for physical immersion when students enter into learning situations and experiment with educational material [7]. Modern technologies such as 3D rendering and virtual images allow users to create more detailed and immersive visual and auditory sensory experiences [8].

Online games serve as a prototype for the metaverse and share common features such as virtual economies, strong virtual identities, social interaction, creativity, and immersive experiences [9]. Game-based learning is well-suited for utilizing the metaverse in education [10]. Gamified learning, supported by the educational metaverse, uses virtual and augmented reality, artificial intelligence, and other modern technologies to make learning a goal in itself, with immersive games as the primary tool for integrating knowledge and entertainment [11]. The concept of gamification has evolved significantly in recent years, especially with the introduction of the metaverse in 2021, redefining gamified learning as a full-fledged virtual-real educational space [10]. Gamified learning in the metaverse offers instant feedback and a high-quality immersive experience, creating realistic virtual game worlds that provide students with exciting educational experiences [12]. This research contributes to understanding innovative educational approaches by exploring the effectiveness of gamified learning in the metaverse.

In China and Russia, gamified learning is actively developing and applies to various educational fields. Chinese schools use educational platforms and applications based on gamification [13]. For instance, the application titled "Xueersi" offers interactive lessons and tasks in the form of games. The platform allows students to solve mathematical problems, learn languages, and study other subjects through visually attractive and interactive methods [14]. In the field of corporate training in China, companies also widely introduce gamified learning platforms. Thus, Tencent, one of the largest technology companies in China, uses gamification to train its employees [15]. Medical schools in China also use a gamified approach, which allows students to gain practical experience and improve skills without having to interact directly with patients [16]. In addition, many online platforms

in China, such as VIPKID, offer gamified English language lessons, which include quizzes, games, and other interactive tasks that make the learning process more enjoyable [17]. There are also apps and platforms in China featuring gamified driving simulations [18].

There is also a growing interest in the use of gamification in education in Russia [19]. For example, Russian online schools, such as Skyeng and LinguaLeo, offer online English lessons based on game mechanics to motivate students [20]. The Coursera platform also provides students with access to online courses with gamification elements, which include interactive tasks, additional bonuses, and statuses for students. These features stimulate their active participation in the educational process and improve academic results [21]. Such Russian companies as Proplex and LiveTex introduce gamification into employee training processes. The training programs involve educational games, simulations of work scenarios, and other interactive methods that improve information assimilation and personnel motivation [22].

However, despite the potential of the metaverse and immersive education, there are some challenges and problems. These challenges include issues of security, data privacy, technology accessibility, and access to quality training [23]. In the context of China and Russia, one of the main problems is the availability of technology for all levels of education and different socio-cultural groups [24]. While modern megacities have wide access to high-quality educational metaverses, remote rural areas may remain at a relatively backward level [25].

Thus, the relevance of this research is due to existing challenges and prospects for the development of education in the metaverses. The research motivation is the need to provide high-quality education in the metaverses. In addition, it is necessary to understand the differences between different geographical and socio-economic regions, where the availability of technology can significantly vary. This research is relevant since it gives new insights into the potential and limitations of using gamified learning in metaverses. The study can become the basis for developing recommendations and strategies for the optimal implementation of these technologies in modern education.

The novelty of this study lies in its execution of a comparative analysis of the effectiveness of an educational method employing gamification within a metaverse among students from different regions of China and Russia. Such an approach enables the identification of potential differences in the perception and efficacy of this teaching method among students from metropolises and regions. The findings obtained may serve as a foundation for the development of more targeted educational programs, taking into account the socio-economic and cultural particularities of various regions, as well as for optimizing the use of metaverses in education considering the local context.

## II. Literature Review

The issue of gamified learning in the context of the metaverse attracts the attention of researchers around the world. The analysis of different sources highlighted common trends, problems, and challenges faced by global researchers and practitioners in this field. One of the key trends in the scientific literature is the transition from traditional teaching methods to immersive educational spaces provided by the metaverse. This approach creates training scenarios with a high degree of immersion and maximum use of virtual and real communication environments [26]. Mustafa [27] also argues that the approach activates the motivation of students, causes an emotional response, and facilitates the flow of experience and interactive learning. In the context of gamified learning, the scientific literature emphasizes that the rapid development of technologies, including virtual reality and augmented reality, has transformed gamification in the metaverse [28]. Majuri *et al.* [29] note that the metaverse is a normalized virtual-real educational space that creates new opportunities for gamified learning.

Chen [30] also underlines the importance of how the metaverse changes the ways of interaction with educational content. The three-dimensional presentation of data, the use of multiple sensory channels of interaction (such as touch and smell), and various fantastic scenarios created in the metaverse make learning more immersive and exciting [31]. These elements activate motivation, awaken emotions, and contribute to the flow of experience and the cognitive transfer of knowledge [32]. Onu *et al.* [33] have also note that the metaverse changes the interaction with space and time, allowing students to experience historical events and explore the world of virtual reality. The learning metaverse, as a virtual-real symbiosis learning system, breaks the boundary between the virtual and real world. In other words, it allows for the free movement of learning content and experiences between these environments. As a result, this metaverse meets the diverse needs of students and makes learning more flexible and personalized [34].

Global scientific literature suggests that gamified learning and the metaverse are under active development. Therefore, researchers and practitioners have great opportunities for innovation and experimentation. Lin *et al*. [35] from China emphasize that gamified learning in the metaverse is becoming a useful practice in various educational contexts both in China and abroad. Hinds *et al*. [8] pays specific attention to the fact that universities and schools in China are beginning to implement virtual educational platforms and create metaverses for educational purposes. These experiences can serve as examples for other countries exploring similar approaches to learning. Many studies in this area focus on the development of new pedagogical techniques and methods, considering the peculiarities of learning in the metaverse and the use of gamification. For instance, in the study "Mobile assessment to improve learning motivation of elementary school students in online learning", it was noted that the utilization of mobile assessment to enhance students' motivation can be considered as one of the means of integrating gamification into the educational process. Such an approach has the potential to render the learning process more engaging and captivating for students, which, in turn, may enhance their outcomes and learning productivity [36]. Some authors described innovative educational projects that use the metaverse and gamification for learning. For instance, the project "Manta" is described, wherein students can explore physical phenomena and chemical reactions within a virtual

laboratory employing virtual reality technologies. Zhao *et al.*'s project [37] provides an interactive and immersive learning environment, encouraging students toward active engagement in scientific inquiry. Additionally, Yeh *et al.* highlight the "Math-Island" project, which constitutes an educational game where students solve mathematical problems and puzzles while navigating through a virtual world. Not only does the project assist students in enhancing their mathematical skills, but it also fosters their logical and problem-solving abilities [38].

The analysis of scientific literature has revealed some conflicts and contradictions in theoretical and methodological approaches to gamification and the metaverse. For example, the debate on how to integrate virtual elements into the learning process, as well as how to balance between entertainment and education, remains relevant. There are also security and ethical aspects of using the metaverse in education, including issues of data privacy and accessibility of learning for all categories of students. The analysis also identified gaps and limitations in existing research. Despite considerable attention to gamification and the metaverse, there is a need for additional research to assess the effectiveness and long-term consequences of the approach. It is also necessary to continue research into local contexts and cultural characteristics.

The study aims to evaluate the effectiveness of virtual gamified learning based on the metaverse in the educational process in terms of forming student personal competence. The main research tasks were the following:

- Analyze students' experience and knowledge in the field of gamification in the metaverse in education;
- Study students' perception of gamified learning and the metaverse as an educational tool and their capability to influence personal competence;
- Evaluate students' interest in using virtual digital metaverse-based programs in the learning process;
- Identify possible obstacles and limitations that students face when interacting with virtual video games and the metaverse in education;
- Assess the impact of using virtual gamified learning based on the metaverse on the formation of student personal competence;
- Determine differences in the perception of gamification in the educational metaverse between students from megacities and students from regions, given the specifics of social and resource context.

## III. Methods and Materials

### A. Research Design

This study used a survey conducted among students to determine the features and effectiveness of using gamified learning based on the metaverse in education. Appendix A presents the text of the questionnaire developed by the authors. A comprehensive approach was employed for the analysis of the obtained data, incorporating correlation analysis, linear regression analytics, and Cronbach's alpha validity and reliability tests. Correlation analysis was utilized to ascertain the relationships between students' satisfaction levels with the utilization of virtual video games in education and their efficacy in learning. Linear regression analytics facilitated the identification of potential dependencies between the specified variables and their impact on the educational process. The reliability and validity of the questionnaire were assessed through the application of the internal consistency test using Cronbach's alpha coefficient calculation method [39]. These methods were employed to attain a deeper understanding of the influence of gamification and the metaverse on the development of students' competencies.

### B. Sample

The study sample consisted of 400 university students from various academic fields. The age of the participants was 18 to 25 years. In the sample, 200 students studied in Beijing (Peking University) and Moscow (Sechenov First Moscow State Medical University), megacities with highly developed infrastructure and access to advanced technologies. The other 200 students were from Zhenjiang (Jiangsu University) and a region of Russia (Pacific State Medical University). These students may have limited resources and access to modern educational technologies. Respondents were selected using the principle of simple random sampling. This facilitated the acquisition of a representative sample of 400 students, reflecting variances in access to educational technologies and resources across different regions. The method of selecting respondents was simple random sampling. The study lasted for 30 days (from 04/05/2023 to 05/05/2023).

### C. Survey

The authors developed a structured survey consisting of 12 questions to collect data. The survey included questions concerning previous experience of using virtual video games in education, assessment of effectiveness, level of motivation, impact on personal competence, and satisfaction with the use of virtual video games in the educational process. The questionnaire was developed based on current theoretical foundations and prior research in the field of gamification and education. The verification of the questionnaire's validity and reliability was conducted using methods of internal consistency analysis and test-retest. The results indicated a high degree of consistency and stability in responses, confirming the validity and reliability of the questionnaire utilized. For the analysis of survey responses, categorization was performed, and numerical values were assigned to each possible answer. This allowed the transformation of respondents' answers into quantitative data, ensuring the accuracy of the statistical analysis. The assigned values are presented in Appendix B.

### D. Statistical Processing

The obtained data was subjected to statistical processing in the SPSS-12.0 program. The statistical error of the survey results does not exceed 1.3%. Correlation analysis and linear regression analytics were performed using Microsoft Excel.

### E. Research Limitations

This study covers only a sample of students. Therefore, the results are impossible to extrapolate to a wider audience. In addition, the individual characteristics and preferences of the participants might have distorted the results of the survey

analysis. Despite the careful design of the questions, the survey may fail to capture all aspects of the impact of virtual video games on education. Therefore, some aspects may remain underestimated or overlooked. In addition, the study focuses on assessing students' perceptions. It may be necessary to consider more objective criteria for the effectiveness of using virtual video games in education.

### F. Ethical Issues

The research observed ethical standards and principles of confidentiality. All the survey participants were informed about the purpose and nature of the study, and their participation was voluntary. The personal data of the study participants remains in private access and is stored following the Chinese Law on Personal Data Protection (2021) and the Federal Law of the Russian Federation No. 152-FZ on Personal Data (2006). The Research Ethics Committee of China and Russia approved the study.

## IV. Results

The survey revealed that educational applications with metaverse-based gamification provide students with the opportunity to actively interact with educational content. This interaction deepens their understanding of the material and increases interest in learning. The survey also showed that the majority of the students rated the method of using virtual video games in education as effective (45%) or very effective (35%). Thus, the fascinating experience of virtual video games increases motivation and interest in learning, which is especially important in modern education. Fig. 1 illustrates the effectiveness of using virtual video games in education.

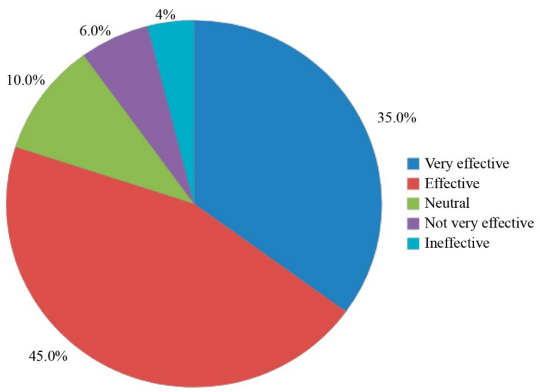


Fig. 1. The effectiveness of using virtual video games in education. Source: developed by the authors.

The study participants also noted that the use of virtual video games in education allowed them to develop a variety of skills and gain new knowledge (46%). This method enriched the learning process and facilitated the acquisition of practical skills. In addition, the students expressed high satisfaction with the level of interaction with the virtual environment in virtual video games (38%). This result highlights the importance of virtual environments for education and their capability to provide interesting and interactive learning. The findings show that virtual video games increase student motivation and interest in learning. Many participants (16%) noted that the use of virtual video games greatly increased their motivation and stimulated interest in the studied subjects. Fig. 2 presents the advantages of using virtual video games in education.

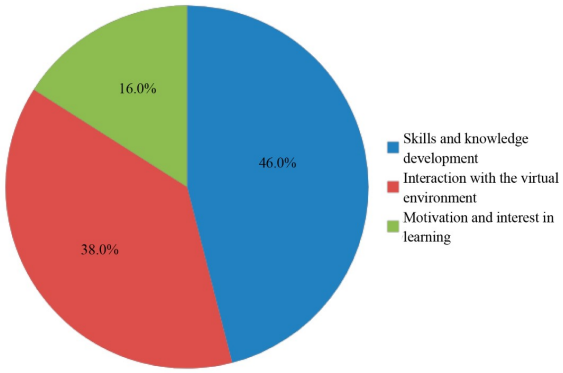


Fig. 2. The advantages of using virtual video games in education. Source: developed by the authors.

In addition, most of the students expressed a desire to see more educational programs based on virtual video games. This fact indicates the need to expand the use of this education method. There was a convincing opinion among students that virtual video games form personal competence. Some of the students noted that they participated in joint projects and assignments using virtual gamified learning. The respondents highly appreciated the possibility of joint learning and interaction in a virtual environment. Most of the students expressed satisfaction with the use of virtual video games in education. The average satisfaction level was 65%. Within the survey, the students also shared various ideas and suggestions for improving the use of virtual video games in education. They expressed interest in more interactive elements in virtual video games, such as more opportunities to interact with the virtual environment and characters. The participants offered to provide a more personalized virtual video game learning experience, according to individual needs and levels of knowledge.

The subsequent stage of the study was a comparative analysis of the responses of students from megacities (Peking University, Sechenov First Moscow State Medical University) and the regions (Jiangsu University, Pacific State Medical University). The analysis determined that 60.5% of students from the regions rated the use of virtual video games as a very effective method of education. In comparison, only 39.5% of students from the megacities shared their opinion. Fig. 3 illustrates the results of the comparative analysis.

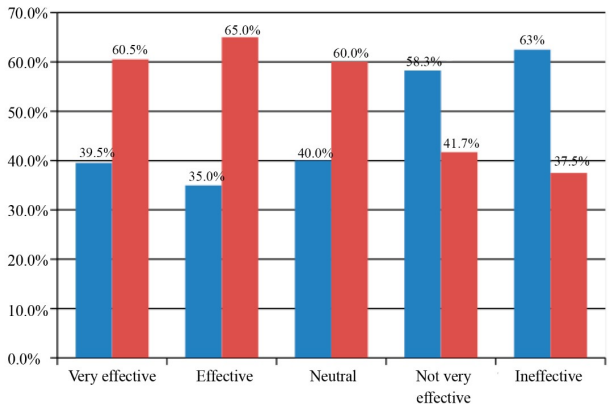


Fig. 3. The comparative analysis of the responses of students from megacities and regions on the effectiveness of using virtual metaverse-based video games in education. Source: developed by the authors.

When asked about the desire to see more educational programs based on virtual video games, 70% of students from the regions responded positively. As for the influence of virtual video games on the formation of personal competence, 60% of students from the regions argued that this influence was positive. According to the perception of virtual video games in education, 55.4% of students from the regions identified "Interaction with the Virtual Environment" as the main advantage (compared to 44.6% of students from megacities). "Skill and Knowledge Development" was also a positively evaluated benefit (42.1% of students from the province compared to 57.9% of students from the metropolis). As for "Motivation and Interest in Learning", 54.7% of students from the regions positively evaluated this aspect (compared to 45.3% of students from the metropolis). Fig. 4 presents a comparative analysis of the responses of students studying in megacities and regions. The respondents also assessed the benefits of using virtual video games in education.

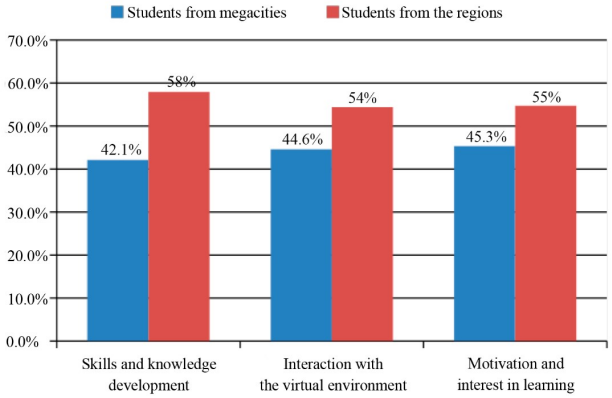


Fig. 4. The comparative analysis of the responses on the benefits of using virtual video games in education. Source: developed by the authors.

The comparative analysis of the responses demonstrated that the majority of students from both locations positively rated the use of virtual gamified learning in education. However, students from the regions were more likely to consider this method of education as "very effective" (60.5% versus 39.5% of students from megacities). This fact suggests a higher value of this teaching method for students from the regions. Skill and knowledge development were positively assessed aspects in both groups. While students from the megacities paid more attention to the development of skills and knowledge, students from the regions focused on interaction with the virtual environment. Therefore, learning priorities may vary depending on the location, as provincial universities may lack resources for practical training of students. The comparative analysis also suggests that students from the regions were more satisfied with virtual gamified learning in education. They also had a more positive perception of this method's impact on motivation and skill development. These differences may be due to differences in the educational environment and the needs of students depending on their location.

During the study, Cronbach's alpha coefficient was calculated to assess the reliability and validity of the developed questionnaire. The results demonstrated a high level of internal consistency among the questions evaluating the effectiveness of using virtual video games in education ($\alpha = 0.82$), and high internal consistency among the questions assessing the satisfaction level with the use of these games ($\alpha = 0.75$). The results confirm that the questionnaire used in this study is a reliable and valid tool for measuring the effectiveness and satisfaction of students with the use of virtual video games in education.

To ascertain the correlation between the level of satisfaction with the utilization of virtual video games and their effectiveness in student learning, measured on a scale from 1 to 10 (where 1 indicates very low and 10 very high satisfaction levels), a correlational analysis was conducted (see Table 1; Fig. 5; Table 2). Upon analysis of the survey data, it was found that the average satisfaction level among students from metropolises was 7.6, while among those from regions, it was 8.4. In evaluating the effectiveness of using virtual video games in education, it was revealed that students from metropolises rated the efficacy of learning at an average level of 7.2, whereas students from regions rated it at a level of 8.1.

Table 1. Satisfaction level of students with the use of virtual video games and their effectiveness in learning

| | Satisfaction level | Efficiency in learning |
|---|---|---|
| Regions | 8.4 | 8.1 |
| Megacities | 7.6 | 7.2 |

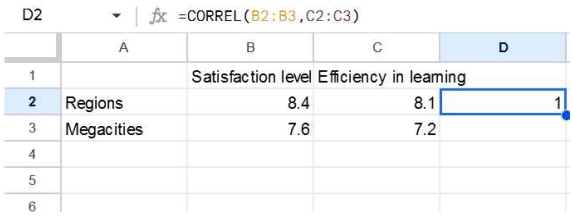


Fig. 5. Correlational analysis of the relationship between satisfaction level with the use of virtual video games and their effectiveness in learning. Source: developed by the authors.

Table 2. Correlational analysis of student satisfaction with the use of virtual video games and assessment of effectiveness in learning

| Level of Satisfaction | Effectiveness Assessment | Correlation Coefficient | Significance at 5% Level | Significance at 1% Level |
|---|---|---|---|---|
| 1 | 1 | 1.00 | Yes | Yes |
| 2 | 2 | 1.00 | Yes | Yes |
| 3 | 3 | 1.00 | Yes | Yes |
| 4 | 4 | 1.00 | Yes | Yes |
| 5 | 5 | 1.00 | Yes | Yes |
| 6 | 6 | 1.00 | Yes | Yes |
| 7 | 7 | 1.00 | Yes | Yes |
| 8 | 8 | 1.00 | Yes | Yes |
| 9 | 9 | 1.00 | Yes | Yes |
| 10 | 10 | 1.00 | Yes | Yes |

The correlational analysis revealed a high positive correlation between students' satisfaction level with the use of virtual video games in education and their assessment of the effectiveness of this method. The correlation coefficient was found to be 1, indicating a direct proportionality: the higher the satisfaction level, the higher the effectiveness rating. The results are statistically significant at both the 5% and 1% levels, confirming the reliability of the correlation. High levels of satisfaction are directly correlated with high effectiveness ratings, highlighting the importance of student satisfaction for the perception of the benefits of gamified learning. This result confirms that students who experience

greater satisfaction from using virtual video games in education tend to perceive this method as more effective. Such a dependency could be a crucial aspect in decision-making regarding the implementation and development of educational programs based on virtual video games.

Within the scope of this study, linear regression analysis was also conducted to assess the relationship between satisfaction levels and the effectiveness of using virtual video games in student education. To achieve this, the mean values of satisfaction level and learning effectiveness among students from metropolises and regions were utilized (see Table 1).

The linear regression was computed using the formula $Y = aX + b$, where X represents the satisfaction level of students with the use of virtual video games, Y denotes the effectiveness of using virtual video games in education, a signifies the slope coefficient of the regression line, indicating the extent to which learning effectiveness changes when the satisfaction level increases by one unit, and b stands for the intercept, reflecting the expected learning effectiveness when the satisfaction level is zero.

During the analysis, it was determined that $a = 0.0551$ and $b = 0.2058$. A standard significance level of $p < 0.05$ was used to evaluate the statistical significance of the correlational analysis and linear regression. The results of the correlational analysis indicated a high positive correlation between students' satisfaction levels and their perception of the effectiveness of using virtual video games in education ($r = 1$, $p < 0.05$). These findings suggest that students who experience higher levels of satisfaction from using virtual video games in education are more likely to perceive this method as effective. The linear regression confirmed this relationship, showing that each additional point in students' satisfaction levels corresponds to an increase of 0.9 points in the effectiveness rating of education ($\beta = 0.9$, $p < 0.05$).

The coefficient of determination ($R^2$) amounted to 0.833, indicating that approximately 83.3% of the variability in the variable "Learning Effectiveness" is explained by the satisfaction level. The Pearson correlation coefficient between the satisfaction level and learning effectiveness was found to be 0.912, indicating a strong positive correlation between these two variables. Thus, the results of this study confirm that the satisfaction level of students with the use of virtual video games in education influences their effectiveness in this domain.

The data analysis revealed some discrepancies between the results of the correlational analysis and the Pearson correlation coefficient. Specifically, the correlational analysis identified a fully positive association between the satisfaction level and the effectiveness of using virtual video games in education. However, such a result is not typical and may indicate a systematic error or the presence of other influencing factors. In contrast, the Pearson correlation coefficient, which more reliably reflects the degree of linear dependence between variables, demonstrated a strong positive correlation between students' satisfaction levels and learning effectiveness. Such discrepancies may be attributed to sample peculiarities or the methodology of measuring variables. Thus, although the correlational analysis indicated an ideal positive association between students' satisfaction level and the effectiveness of using virtual video games in education, a more reliable assessment of this relationship within this study would be considered the Pearson correlation coefficient.

Furthermore, during the study, the effectiveness of using virtual video games in education was calculated for students from metropolises and regions:

- For students from metropolises with a satisfaction level of 7.6, the effectiveness in learning = 0.6232.
- For students from regions with a satisfaction level of 8.4, the effectiveness in learning = 0.6686.

The results of the linear regression indicated that students' satisfaction level influences the effectiveness of using virtual video games in education. For students from metropolises with a satisfaction level of 7.6, the average effectiveness score stood at 0.6232, indicating that this method of instruction was able to deepen their knowledge and enhance their interest in the learning process. Students from regions with a satisfaction level of 8.4 demonstrated an even higher level of learning effectiveness, with an average value of 0.6686. This suggests that virtual video games in education proved to be more effective for students from regions compared to their counterparts from metropolises. These findings affirm the importance of considering regional peculiarities when organizing the educational process using virtual video games. Students from regions may be more receptive to new technologies and engage more actively with educational resources, contributing to the higher effectiveness of this instructional method. To enhance the effectiveness of educational programs in metropolises, it is essential to consider the characteristics and needs of students in this group, possibly through the development of more individualized and adapted approaches to using virtual video games in the learning process.

All respondents also expressed a desire to see more educational programs based on virtual video games, but students from the provinces more actively supported this idea. The comparative analysis also showed that students from the regions more positively assessed the impact of virtual gamified learning on the formation of personal competence. Further research and adaptation of educational programs can more deeply investigate these differences and improve the quality of education for both groups of students. The findings emphasize the importance of using virtual gamified learning based on the metaverse in education. The survey results confirm the positive impact of this approach on student motivation, satisfaction, and personal competence.

## V. Discussion

The comparison of the obtained data with similar studies revealed that many world researchers positively assess virtual video games in education. The results of this study confirm similar studies, which also note that students tend to consider virtual video games as an effective learning tool [40]. In addition, the current results indicate that this method of teaching has a particularly high value for students from the provinces. This result is consistent with observations from other papers by scientists. Students from provinces and

regions of different countries may experience great difficulties in obtaining a quality education [41]. The reason can be limited resources and access to modern technologies [42]. The presented results confirm the study by Sholichah *et al*. [43]. This author revealed the positive effect of virtual video games on the motivation and level of interest of students in learning. However, the current study pays more attention to the differences in perception between students from the megacities and the province. These data broaden existing knowledge in the field of gamification in education. In addition, the results of this research support the concept of adapting educational programs to the needs of students in different regions. This conclusion corresponds to the thesis on the importance of flexibility in education and personalized approaches presented in the study by Peng [44]. The current findings also confirm the results of Huang *et al*. [45]. The authors point to significant differences in educational practices and resources between megacities and provinces. Students from the province may face limited access to modern educational technologies and resources, which makes the use of virtual video games more attractive and important for them.

The presented research also emphasizes the relevance of the introduction of virtual video games in education and their ability to increase student motivation and interest. These conclusions support the ideas about the influence of modern technologies on the learning process presented by Shin and Kim [46]. The results presented in this paper are consistent with the studies by Hung *et al*. [47] and Proulx *et al.* [48]. They also argue that the needs and motivation of students may vary depending on their socio-cultural context. Virtual video games, which present interactive and exciting educational opportunities, can have a stronger impact on student motivation in educational institutions with limited resources.

In addition, this study underlines that students who use virtual video games more actively develop skills and acquire new knowledge. This finding is similar to the results of the study by Hilliard and Kargbo [49]. The current research also demonstrated a high percentage of students who want more educational programs based on virtual video games. This fact indicates the need to expand the use of this method. Barr [50] presented similar conclusions, highlighting the significance of metaverses in education. The importance of interacting with the virtual environment confirmed by the current results correlates with the study by Kim *et al.* [51]. The latter revealed the influence of the educational environment on student perception of teaching methods.

Thus, this study not only confirms previous research. It also presents new data on the location of students, which impacts their assessment and perception of virtual video games in education. These location-related differences and similarities may be due to the educational environment, sociocultural factors, and resources available to students in megacities and provinces. The results of this study emphasize the importance of using virtual video games based on the metaverse in education. The paper presents evidence of their positive impact on student motivation, satisfaction, and the formation of personal competence. These results can serve as a basis for improving educational programs and the quality of education for students from different countries, regions, and socio-economic strata. Thus, the study creates the foundation for further research in the field of education and gamification.

## VI. Conclusions

This study provides valuable insights into the effectiveness of using virtual gamified learning based on the metaverse in education. This study comprehensively analyzes students' experiences and knowledge regarding gamification in the educational metaverse. It examines students' perception of game-based learning and the metaverse as educational tools and evaluates students' interest in using virtual digital programs based on the metaverse in the learning process. The study also identifies potential obstacles and limitations that students face when interacting with virtual video games and the metaverse in education, assessing the impact of using virtual gamified learning based on the metaverse on the formation of students' personal competencies. Additionally, the study identifies differences in the perception of gamification in the educational metaverse between students from metropolitan areas and students from regions, demonstrating the specificity of social context and resource accessibility. The findings revealed that the majority of students rated this method as effective or very effective, underscoring its potential as an innovative educational approach. Particularly noteworthy is the strong stimulation of motivation and interest in learning among more than 60% of students, as well as the practical enrichment of knowledge and skills reported by 46% of respondents. The positive impact of gamified learning on the formation of student personal competence was also confirmed. Importantly, the study identified differences between students from megacities and regions, highlighting the need to adapt educational programs to the specific needs of different student groups. Students from regions exhibited a more positive evaluation of gamified learning, emphasizing its advantages in personal competence formation and expressing a greater desire for more educational programs based on this approach. In contrast, students from megacities had different expectations and less positive responses. During the study, it was also found that virtual gamified learning based on the metaverse contributes to the development of students' personal competencies. Additionally, the majority of respondents expressed a desire to see more educational programs based on virtual video games. They also shared various ideas and suggestions for improving the use of virtual video games in education, including the integration of more interactive elements and ensuring a more personalized learning experience in the virtual environment.

The practical implications of these findings are significant for educational institutions and developers of educational programs. They suggest the potential for integrating gamification techniques into educational projects to enhance student motivation and interest, as well as to improve their skills and knowledge. This study contributes to the existing knowledge on education and gamification by offering new insights into student perceptions of metaverse-based learning methods. Future research could delve deeper into the impact of different types of virtual gamified learning and metaverses on the educational process. Comparative studies across different cultural and socio-cultural contexts could further

enrich our understanding of the effectiveness of virtual educational programs.

The research objectives were successfully addressed as follows:

1) The survey indicated that the majority of students had prior experience with virtual video games in education: 45% considered them effective, while 35% deemed them very effective.
2) Students positively evaluated gamified learning, noting its effect in terms of increased motivation and interest in learning. 46% of respondents reported acquiring new skills and knowledge through this method.
3) A high level of interest was identified among students regarding the use of virtual digital programs based on the metaverse. A significant portion of respondents expressed a desire to see more educational programs based on virtual video games.
4) The study revealed various issues in students' interaction with virtual video games and the metaverse, including limitations in resources and access to modern educational technologies, particularly among students from regions with lower technological advancement.
5) The research confirmed that virtual gamified learning positively impacts the development of students' personal competencies. Students from regional areas demonstrated higher levels of satisfaction and effectiveness compared to students from metropolitan areas.

## APPENDIX

### A. Appendix A: The Questionnaire for the Survey

**The Effectiveness of Using Virtual Video Metaverse-Based Games in Education**

1. What types of educational applications or programs based on virtual video games have you used for learning?
- Virtual reality games (VR)
- Augmented reality games (AR)
- Virtual world simulators
- Others (specify)

2. How do you assess the effectiveness of using virtual video games for learning purposes on a scale from 1 to 10, where 1 is very ineffective and 10 is very effective**?**

3. What do you think is the advantage of using virtual video games in education? (specify)

4. What skills and knowledge have you gained through the use of virtual video games in education? (specify)

5. Are you satisfied with the level of interaction with the virtual environment in virtual video games?
- Yes
- No
- It is hard for me to answer

6. How have virtual video games affected your motivation and interest in learning?
- Significantly increased motivation
- Increased motivation
- Neutral
- Decreased motivation
- Significantly decreased motivation

7. Would you like to see more educational programs based on virtual video games?
- Yes
- No

8. Do you think virtual video games influence the formation of your personal competence?
- Yes
- No
- It is hard for me to answer

9. Have you participated in joint projects or assignments using virtual video games? If so, describe your experience.

10. Rate your overall satisfaction with the use of virtual video games in education (on a scale from 1 to 10, where 1 means not satisfied at all, 10 means very satisfied).

11. What improvements or changes would you suggest to the use of virtual video games in education?

12. Describe additional aspects or issues that you consider important regarding the use of virtual video games in education.

### B. Appendix B: The Numerical Values Assigned to Respondents' Answers to the Questionnaire Items

**The Effectiveness of Using Virtual Video Metaverse-Based Games in Education**

1. What types of educational applications or programs based on virtual video games have you used for learning?
- Virtual reality games (VR) - 1
- Augmented reality games (AR) - 2
- Virtual world simulators - 3
- Others (specify) - 4

2. How do you assess the effectiveness of using virtual video games for learning purposes on a scale from 1 to 10, where 1 is very ineffective and 10 is very effective?
- scale from 1 to 10, where 1 is very ineffective and 10 is very effective

3. What do you think is the advantage of using virtual video games in education? (specify)
- In-depth understanding of the material - 1
- Increased interest - 2
- Increased motivation - 3
- Skill development - 4
- Gaining new knowledge - 5

4. What skills and knowledge have you gained through the use of virtual video games in education? (specify)
- Practical skills - 1
- Theoretical knowledge - 2
- Social skills - 3
- Technical skills - 4

5. Are you satisfied with the level of interaction with the virtual environment in virtual video games?
- Yes - 1
- No - 2
- It is hard for me to answer - 3

6. How have virtual video games affected your motivation and interest in learning?
- Significantly increased motivation - 1
- Increased motivation -2
- Neutral - 3
- Decreased motivation - 4

- Significantly decreased motivation - 5

7. Would you like to see more educational programs based on virtual video games?

- Yes - 1
- No - 2

8. Do you think virtual video games influence the formation of your personal competence?

- Yes - 1
- No - 2
- It is hard for me to answer - 3

9. Have you participated in joint projects or assignments using virtual video games? If so, describe your experience.

- Positive experience - 1
- Neutral experience - 2
- Negative experience - 3

10. Rate your overall satisfaction with the use of virtual video games in education (on a scale from 1 to 10, where 1 means not satisfied at all, 10 means very satisfied).

- scale from 1 to 10, where 1 means not satisfied at all, 10 means very satisfied

11. What improvements or changes would you suggest to the use of virtual video games in education?

- More interactive elements - 1
- More personalized experience - 2
- Better technical execution - 3
- More educational content - 4

12. Describe additional aspects or issues that you consider important regarding the use of virtual video games in education.

- Technical problems - 1
- Pedagogical aspects - 2
- Interactivity - 3
- Accessibility and resources - 4

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## AUTHOR CONTRIBUTIONS

KAS conceived and designed the analysis; OS collected the data; VS contributed data or analysis tools; EM performed the analysis; KAS and EM wrote the paper. All authors read and approved the final manuscript.

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