Teacher’s perspective for didactic-methodological potentials of metaverse

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Abstract

Education in the 5.0 era requires precise didactic-methodical reflection on using AI driven educational technology to create innovative and stimulating teaching environments. One of the key challenges facing the educational system determines the main research question of this paper, and relates to how to improve the existing teaching models with the latest technological solutions such as metaverse. This study aims to assess the 219 in-service primary school teachers’ perspectives about the metaverse concept and to examine the views on the possible didactic-methodological potential of integrating metaverse in education. Data for this study were collected using an online survey as the primary research instrument, incorporating a 5-point Likert scale for attitudes about one prospective teaching scenario, and then were interpreted using descriptive statistics, the Chi-squared test and ANOVA. The results of research show (still) insufficient knowledge of the term “metaverse”. Also, aspects of the teaching process for which our sample of teachers believes that the metaverse can have a positive impact were highlighted, as well as how three key factors (work experience, time spent on the computer, and grades) influence these attitudes. Based on the observed scenario, participants believe that metaverse could have greater contribution to different aspects such as better evaluation of student work, improvement of existing teaching models etc. Implications for future research may be directed to fully understand the educational benefits of metaverse. It is essential to explore teachers' perspectives across various educational levels, using diverse samples and teaching scenarios, as well as to investigate the process of evaluation and impact on child development.

Key words:

artificial intelligence; attitudes; benefits; in-service education; metaverse.

Introduction

The rapid technological advancements of the 21st century, particularly the growing influence of artificial intelligence (AI), call for a thorough reevaluation of teaching methods and the

integration of digital tools to create dynamic and stimulating learning environments. Soon, groundbreaking technologies are set to revolutionize the educational experience, redefining what we currently perceive as innovative. Among these is the metaverse, as a prospective form of immersive reality technology with the potential to establish a completely new framework for education.

The term "metaverse" is a compound word formed by "meta" (meaning beyond or transcending) and "verse" (derived from "universe," denoting the whole world), referring to a new virtual universe that exists beyond the real world (Zhang et al., 2022). Today we come to different points of view on the metaverse, from that a metaverse merely be a new term for virtual reality (VR), augmented reality (AR), and mixed reality (MR) to it is much more than that (Park & Kim, 2022 according to Hwang & Chien, 2022). Extended reality (EX) technology, as an umbrella term for VR, AR, and MR, is just one aspect of the metaverse ecosystem but is commonly explored alongside the metaverse because it is an existing set of technologies that offers cues as to what may lie ahead in future metaverse applications, especially given its immersive qualities (UNICEF & DIPLO, 2023).

AI generally plays an important role in the metaverse (Hwang & Chien, 2022). Because of this statement, the most comprehensive definition for understanding the concept of the metaverse is a worldwide virtual environment, a type of Web 3.0 tool with the potential to reimagine education with extended reality (XR) is expected to introduce a new and unique way of learning (UNESCO IITE & NetDragon, 2023). As is clear from the findings (Alfaisal et al. 2024; Mystakidis, 2022; Chua & Yu, 2024; UNESCO IITE & NetDragon, 2023) a metaverse:

1) refers to a three-dimensional model of the internet often referred to as Web 3.0., an immersive, virtual world (multiuser platforms) - an interconnected web of social, networked immersive environments that provide a more immersive experience than the internet;
2) interaction occurs between the users and digital artifacts in real-time, irrespective of their location;
3) participants themselves can create an avatar (a configurable digital body - a lifelike manifestation of the user who can look quite different) and users enter the metaverse using their avatars to interact with other avatars and digital objects in virtual space, with the opportunities to shop, play games, work, socialize, and learn;
4) integration of the real as well as physical universe through which the users can imagine various and myriad digital mirrors of the actual world and mirrors that are not present in the actual world for different purposes;
5) technically the system can work without leaving the actual world while maintaining a consistent connection with the virtual world without any time restrictions.

The findings (Al-kfairy et al., 2024) reveal that user adoption of the metaverse in educational contexts is influenced by multiple factors at technological, environmental, and individual levels.

From a technological perspective, the core of the metaverse is based on artificial intelligence (AI). One of the most significant applications of AI’s simulation capabilities is its ability to make non-player characters (NPCs) behave like real humans in the metaverse. This, in turn, enables learners to interact and collaborate with intelligent NPC tutors, NPC peers, and NPC tutees, as well as other human learners represented as avatars (Hwang & Chien, 2022).

Currently, interactive 3D platforms such as Roblox, Minecraft, and Fortnite serve as models for the future development of the metaverse (Chua & Yu, 2024). This opens up a vast range of opportunities for implementing an intelligent metaverse system to support the development of

innovative educational paradigms.

To unlock the full potential of the metaverse to support different learning scenarios (environmental levels) in educational settings, many meta-analyses have been conducted (Flores-Castañeda et al., 2024; Geng & Su, 2024; Tlili et al., 2022) refer to a metaverse the potential to lead to the improvement of the virtual (online, blended and hybrid) learning as well as experiential, game-based and problem-based learning, collaborative, cooperative, self-directed learning), and emotional (involving the regulation of emotions). Moreover, curriculum gamification in the social virtual world opens new interdisciplinary cooperation that can enrich and differentiate in comparison to current online learning methods (Jovanović & Milosavljević, 2022). Through a carefully crafted combination of the best aspects of technology and essential pedagogical strategies, traditional teaching can be enhanced and transformed into a more engaging and stimulating learning environment. The virtual world enabled by the metaverse can shift the traditional teaching model from a static approach to a dynamic one across diverse learning scenarios, fostering student-centered collaboration by offering learning resources and real-time assessments (Díaz, 2020).

The main potential on the individual level lies in the following: an immersive interactive experience for learning without time and space limitations, visualization of risky situations and historical periods, enhancing STEM education, individualization according to the student's pace, inclusive environment, motivation, engagement and playful activities in the teaching process, improving communication and developing creativity, developing skills that require long-term practice, reducing feelings of anxiety and depression, cost reduction, prevention of misconduct and school violence (Hwang & Chien, 2022, Lin et al., 2022, Ristić et al., 2022). On the other hand, the key challenges of adopting the metaverse open new questions about: hyperrealistic experiences, identity formation, limited view of social interaction, health risks and physical safety, exposure to inappropriate content, data security and privacy, increase in digital violence, commercial exploitation and manipulation, parental control, increasing global inequality (UNICEF & DIPLO, 2023).

The integration of the metaverse into education will depend on various factors, significantly influencing all critical aspects of the system. To align with the needs of modern learners, schools must evolve, discarding outdated practices that traditional education has proven ineffective. The need for teachers to develop new competencies to effectively utilize and integrate AI technologies into their teaching theory and practice was emphasized (Mandić, 2024). This involves aligning AI tools with learning objectives, designing learning activities based on artificial intelligence, and leveraging AI to support various teaching strategies in the application of modern educational technologies. Moreover, to ensure more effective implementation of the metaverse in the future, it is essential to offer technical support to teachers, encourage training both within and beyond the classroom through synchronous and asynchronous methods, and create a dynamic, interactive, and collaborative virtual platform for students (Tlili et al., 2022).

Understanding the changes brought by intelligent metaverse systems will potentially completely alter the methodological approach to teaching that is deeply rooted in the educational systems of many countries. Taking into account the predictions of the US survey that by 2027, Generation Z respondents (born between 1997 and 2012) will spend an average of 4.7 hours per day in metaverse spaces (Aielloto et al., 2022) it is extremely important to consider what kind of future we want for education with the metaverse. The study (Nguyen et al., 2025) explored metaverse literacy in cognitive, affective, behavioral, and ethical learning domains with first-year bachelor’s students enrolled in an undergraduate program. Their findings show that the learning

experience with the metaverse significantly alters students' perceptions of the effort required for adoption and improves their metaverse literacy in education.

To answer the question of how to organize quality and efficient time spent in the metaverse and according to which criteria, in-service as well as pre-service teachers need to be prepared for the critical evaluation of situations where the metaverse can provide learning like never before and trained to prevent reported challenges and risks of implementing metaverse in future. The top of that, educational stakeholders need to assess the readiness of educational systems for such types of changes.

The impact of incorporating AI and the metaverse into education that remains largely unexplored in most research studies (Nguyen et al., 2025; Almeman et al., 2025), but the need is emphasized for academic and industry professionals to recognize the essential need to properly equip students and graduates for the digital age with this kind of technology (Xu & Impagliazzo, 2024). In connection with that, the main research question of this study focused on exploration whether advanced educational technologies like the metaverse can enhance existing teaching models. It examines teachers' familiarity with the metaverse, it's perspectives on potential benefits for education, and the impact of work experience, grade level, and computer usage on their attitudes.

According to research in other countries, we will see that teachers generally notice similar, greater, or lesser potentials that have an impact on their attitudes toward the application of metaverse. Somewhat similar to our participants, English as a Foreign Language (EFL) respondents in Turkey believe that the use of metaverse can contribute to the understanding of abstract topics in younger students. Also, results showed that participants have a positive attitude towards integrating the metaverse into English language teaching, and it was perceived through suitability for being innovative, experiential learning and authentic tasks, developing intercultural communicative competence, task flexibility, for young learners, to provide the transition from theory to practice, for gamified teaching, for avatar use, for motivating participants, to expose participants to the target language. Negative attitudes were perceived through problems in teacher and parent preferences, problems in the psychology of users, in setting boundaries, management, and security, in accessing materials/expenses, problems in using with young learners, in using avatars, the bad influence on the mental and physical health of students, as well as the possibility that students mix the virtual world and reality (Kebeci, 2024). In a qualitative study on the metaverse, teachers from different schools, fields of study, and ages also from Turkey believe that the application of the metaverse will have both positive and negative impacts on humanity. Most of them believe that the metaverse is important for education and that it would make knowledge more permanent, high-quality, and efficient, as well as contribute to distance education. Teachers have seen the advantages of the metaverse in terms of active learning, practical work of experiments, and reducing the traditional form of work. They see the disadvantages through the problem of socialization and the possibility of escaping from real life, mixing real and virtual situations, health problems, and dependence on technology. Most teachers would decide to use the metaverse in teaching (Semerci et al., 2024).

As mentioned, artificial intelligence (AI) is the key to the development of the metaverse in general. Accordingly, the development of artificial intelligence highlights the need to enhance teachers' digital competencies. If the metaverse evolves to meet educational needs and becomes adapted (both hardware and software) for use in school settings, it will undoubtedly be of great importance for the key digital competencies for AI (ZVKOV, 2023) to include competencies for the use and integration of the metaverse. A little further away from us, respondents from six different

parts of the world within the K-12 level of education indicated that teachers' with more years of work experience have less concern about AI, but do not see any more benefit. Interestingly, no evidence has been found that the age of the subjects, the gender identity, the level of education or the subject taught by the teachers influence the perceived advantages or concerns with the application of AI. Teachers' in Brazil, Israel, and Japan see the advantages of using AI in education more than teachers in Norway, Sweden, and America. Interestingly, concerns are more prominent in Israel, Norway, and Sweden than in the USA, Brazil and Japan (Viberg et al., 2024). All this kind of studies, led us to another additional research question whether exist positive or negative views on the metaverse.

Methods

The research seeks to address the central question: Can the latest technological solutions in educational technology, such as the metaverse, improve existing teaching models? This inquiry focuses on the potential of the metaverse to enhance educational practices and learning outcomes.

The research centers on in-service teachers who teach in all grades of Serbian primary school [1] from 1st to 8th grade, to assess their awareness of the metaverse concept. Additionally, the study examines their perspectives on the possible didactic-methodological potential of integrating the metaverse into education. The research explored how the integration of IT-developed teaching methods and metaverse—can revolutionize traditional teaching models.

To gather data, the instrument used in this study was an online survey. This approach allowed for efficient data collection from a broad sample of 219 in-service teachers', ensuring diverse insights into their understanding and attitudes toward the metaverse. The research utilized a descriptive methodology to analyze the collected data. This method provided a comprehensive overview of teachers' awareness, perceptions, and readiness to adopt the metaverse in their teaching practices, offering valuable insights into the future of educational technology integration. The potentials of the metaverse particularly stood out in teaching implementation and evaluation, as well as in strengthening the holistic perspective of experiential learning.

Four research tasks we dealt with in this research is:

1) How familiar are teachers with the terminological definitions of augmented reality, virtual reality, and metaverse?
2) To what extent do teachers think that metaverse can potentially contribute to certain aspects of educational work?
3) What influence do the variables of work experience, grade, and time using the computer have on teachers' attitudes?
4) Are there differences in attitudes, specifically whether some teachers exhibit more positive or negative attitudes?

The participants were first provided with a brief description of what the metaverse is, along with a scenario that could represent a prospective model of an educational situation. This prospective teaching scenario is the result of the winning project *The Empowered Teachers for the META future* of the GCD4FE (The Global Competition on Design for Future Education) 2022 and called Ancientcraft.

According to Ristić et al. (2022) this is a STEM education scenario designed to promote cultural identity by raising awareness of cultural heritage which enables learners to travel through time to experience different historical periods related to manufacturing (see Figure 1 and Figure 2).

The core focus is on problem-solving, hands-on learning, role-playing, and/or game-based learning where students are empowered to develop skills in traditional crafts. Students get hints and timely feedback on how to create a specific Serbian rug called “ćilim” from an NPC avatar as a tutor. For a more objective evaluation of students in the metaverse, a monitoring system constantly operates in the background of this metaverse environment, providing effective statistical reports to in-service teachers' based on Digital Bloom's Taxonomy as evaluation criteria, collecting feedback, and fostering holistic early childhood development. This designed evaluation model can serve as ing and more objective student assessment.



Figure 1. Ancientcraft (video) Figure 2. Ancientcraft (immersive interaction between student and avatar)

Upon viewing the video, the participants were instructed to assess their perspectives regarding the didactic-methodological potentials of the metaverse using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The Likert scale is oriented on one side towards a more qualitative approach to teachers' work, while on the other side, it encompasses students' competencies. The potential of the metaverse was significant for improving the work of teachers' and educators are covered through statements such as: to what extent does the metaverse contribute to improving existing teaching models (problem-based, project-based, research-based), better evaluation of student work, and better monitoring of student performance. For students, this is encompassed through all three domains - educational, cognitive, and psychomotor. In this regard, we wanted to investigate the extent to which respondents believe that the metaverse contributes to student motivation, cultural identity, better understanding of content about Serbian tradition, acquisition of procedural knowledge in carpet making, and development of fine motor

skills. By applying the Chi-square test, we wanted to examine the relationship between teachers' attitudes about the potentials of the metaverse and factors such as respondents' work experience, computer usage, and the grade they teach, i.e., with independent variables. Also, the application of ANOVA statistical procedure, and tests such as: T-test and Post-hoc test (Tukey HSD, Bonferroni) aimed to examine variations in attitudes towards the metaverse.

Results and Discussion

For experimental research, a question was asked, *Can the latest technological solutions in educational technology such as metaverse improve the existing teaching models?* This research aimed to assess the in-services teachers' awareness (in the wider territory of the city of Belgrade) about the metaverse concept and to examine the views on the possible didactic-methodological potential of integrating metaverse in education.

The data collected by the online survey was analyzed using a descriptive research method. Also, in the online survey, we used a conceptual proposal of a prospective teaching scenario with metaverse. Table 1 illustrates the distribution of the research sample by grade and gender. The research sample was 219 in-service primary school teachers (111 teaching grades 1–4, and 108 teaching grades 5–8). In terms of gender, the majority of the sample were females (87.2%), while male teachers accounted for 12.8%. The distribution by grade level was balanced, with 50.7% teaching lower grades (1–4) and 49.3% teaching upper grades (5–8).

In addition to the sample's demographic characteristics, we also selected characteristics related to years of work experience and time spent using computers in daily work. The sample structure is shown in Tables 1 and 2.

Table 1 . Sample structure by grade and gender

Grade	Gender			
	Male	Female	N	f(%)
1-4	8	103	111	50.7
5-8	20	88	108	49.3
N	28	191	219	
f(%)	12.8	87.2		100

Table 2. represents the sample structure based on work experience and the amount of time spent using a computer in daily activities. Work experience was categorized into two groups: less than 10 years and more than 10 years. The majority of teachers (60.3%) had more than 10 years of experience, while 39.7% had less than 10 years of experience (up to 5 years 22.3% (49) and from 5 to 10 years 17,4% (38). Starting from the fact that teachers with more work experience are older, and vice versa - those with less experience are younger, it is an interesting fact that teachers with more teaching experience use computers for more hours per day compared to teachers with less work experience. Regarding time spent using a computer, most teachers (47.9%) reported using a computer for 1–3 hours per day, 32% for more than 3 hours per day, and 19.2% for less than one hour daily.

Table 2. Sample structure by work experience and time using a computer

Work experience	Time using a computer (hours)					
	0	0-1	1-3	>3	N	f (%)
<10	1	26	40	20	87	39.7
>10	1	16	65	50	132	60.3
N	2	42	105	70	219	
F (%)	0.9	19.2	47.9	32		100

To answer the first research task, we examined to what extent, according to the Likert scale of 1-5, in-service teachers' are familiar with terminological definitions of augmented reality, virtual reality, and metaverse. The results are shown in Table 3.

Table 3. Terminological definitions of augmented reality, virtual reality, and metaverse

	Mean	Median	Mode
Augmented reality	2.56	3.00	1
Virtual reality	3.61	4.00	5
Metaverse	1.87	1.00	1

As can be seen from Table 3, the teachers' are best acquainted with the term virtual reality, and the least with the term metaverse, which can be seen based on the mean value of the answers.

The fact that they are most familiar with the term virtual reality is not so surprising because many meta-analyses emphasize the rapid adoption of immersive VR technologies into teaching on a regular basis, thanks to increasingly accessible and affordable hardware (Radianti et al., 2020, Hamilton et al., 2021). Shortly, metaverse will be even more relevant in the educational system, and the potential reason for this result can be found in the fact that it is not yet applied in education in Serbia and that teachers in Serbia do not have training on examples of how to use metaverse in education. A similar result of the research is a qualitative study on the metaverse in education that included 57 teachers from different fields in Turkey. However, 25 teachers had not heard of the metaverse at all, while the rest had heard of it from movies, games, and social networks, but none of the respondents had experienced it. The respondents defined the metaverse as a virtual world and reality, adapting to digital life and avatars. By integrating training for the metaverse, they believe they would be more efficient, secure, and future-ready (Semerci et al., 2024). Developing awareness and encouraging teachers' to reflect on and act towards developing their own and their students' digital competencies is of great importance, considering that teachers have the task of preparing students for the future — through the development of critical thinking, attitudes, focusing on lifelong learning, and similar goals (Mandić, 2024a). Therefore, teachers' must be familiar with these terms, and schools to be equipped so that all those who are involved in education can become familiar with it and implement it in their work with students. Another study highlights that there is still a need for teacher training and awareness of global trends regarding the application of augmented reality in education. The need for AR training is indicated by educators around the world, such as Libya, whose research shows that educators from Libya are not familiar with how they can integrate AR and activities with children, they are not trained for it,

and due to a lack of equipment, they did not prepare activities that include AR (Tutkun, 2024).

The second research task was to examine to what extent in-service teachers' think that metaverse can potentially contribute to certain aspects of educational work. The results are shown in Table 4.

Table 4. Teachers' attitudes on the contribution of metaverse in the teaching process

It contributes to	Mean	Median	Mode
better understanding of the content of Serbian tradition	3	4.0	4
the acquisition of rocedural knowledge about making rugs	3.64	4.0	4
the development of cultural identity	3.74	4.0	4
realistic experience of the past	3.95	4.0	5
reater motivation for research on Serbian tradition	3.97	4.0	4
o the development of fine motor skills	3.0	3.0	4
a greater degree of individualization	3.48	4.0	4
experiential learning	3.76	4.0	4
better monitoring of student work	3.53	4.0	4
a better evaluation of student work	3.47	4.0	4
the creation of a stimulating learning environment	3.91	4.0	4
the improvement of existing teaching models (problem-based, project-based, research-based)	4.0	4.	4

From Table 4, we can see that in-service teachers' generally have a positive attitude about metaverse contribution to the education process. They believe that metaverse has the best potential for improving existing teaching methods (Mean=4.0) and the least potential for improving students' motor skills (Mean=3.0). It is encouraging that the result shows that in-service teachers' primarily believe that the metaverse can enhance evolving teaching models. We can say that they

are sufficiently familiar with the characteristics of innovative models and recognize the potential for their improvement.

Taking into account that schools employ educational staff who have worked using traditional methods as well as those trained to apply developmental teaching models, we were interested in whether teaching experience, the grade they teach, and the amount of time they spend on a computer influence teachers' attitudes. So, the third research task was to examine what influence do the variables of work experience, class and time using the computer have on teachers' attitudes. Results are shown in Table 5.

Table 5. Correlation of factors with the attitudes about contribution of metavers.

	Work experience			Time use of computer			Grade			
It contributes to	χ^2	df	p	χ^2	df	p	χ^2	df	p	
a better understanding of Serbian tradition	8.514	4	.074	6.254	12	.903	6.955	4	.138	
the acquisition of procedural knowledge about making rugs	8.417	4	.077	8.799	12	.720	11.118	4	.025	
the development of cultural identity	5.332	4	.255	8.747	12	.724	3.126	4	.537	
a realistic experience of the past	.730	4	.948	7.782	12	.802	6.599	4	.159	

greater motivation for research on Serbian tradition	12.075	4	.017	13.964	12	.303	7.921	4	.095	
the development of fine motor skills	3.665	4	.453	4.487	12	.973	1.086	4	.896	
a greater degree of individualization	5.805	4	.214	5.537	12	.938	8.240	4	.083	
experiential learning	8.481	4	.075	7.002	12	.858	10.390	4	.034	
better monitoring of student work	8.892	4	.064	9.880	12	.626	6.307	4	.177	
a better evaluation of student work	12.385	4	.015	14.903	12	.247	3.304	4	.508	
the creation of a stimulating learning environment	10.854	4	.028	8.288	12	.762	4.040	4	.401	
the improvement of existing teaching models	10.208	4	.037	8.870	12	.714	4.875	4	.300	

(problem-based, project-based, research-based)	

The *Chi-square test* showed that work experience has an influence on the attitude that metaverse contributes greater motivation for research on Serbian tradition, better evaluation of student work, creation of a stimulating learning environment, and improvement of existing teaching models (problem-based, project-based, research-based) ($p<.05$), but time used on the computer has no influence on metaverse contributes ($p>.05$). On the other hand, the grade influences the attitude that metaverse contributes to the acquisition of procedural knowledge about making rugs and experiential learning($p<.05$). Considering that procedural knowledge answers the question of how something works (Miščević Kadijević, 2011), it plays a crucial role in understanding the processes involved in various tasks.

The One-way ANOVA statistical procedure is applied to examine variations in attitudes towards the metaverse depending on teachers' work experience (up to 5 years, from 5 to 10 years, more than 10 years) and between lower (1-4) and upper (5-8) grade teachers'. Based on separate one-way ANOVAs, it was determined that there are differences in attitudes, both towards the grade and across different years of experience (Table 6).

Table 6. Results of factors with the attitudes about contribution of metavers – ANOVA

	ANOVA				
It contributes to	Work Experience		Grade		
	F	Sig.	F	Sig	
a better understanding of Serbian tradition	2.648	.073	5.178	.024	
the acquisition of procedural knowledge about making rugs	2.919	.056	8.929	.003	
the development of cultural identity	1.904	.151	2.437	.120	
a realistic experience of the past	.428	.653	5.673	.018	

greater motivation for research on Serbian tradition	1.564	.212	5.489	.020	
the development of fine motor skills	.089	.915	.181	.671	
a greater degree of individualization	.670	.513	4.779	.030	
experiential learning	1.315	.271	7.559	.006	
better monitoring of student work	.824	.440	2.228	.137	
a better evaluation of student work	.599	.550	1.641	.202	
the creation of a stimulating learning environment	3.833	.023	3.241	.073	
the improvement of existing teaching models	3.922	.021	3.660	.057	
(problem-based, project-based, research-based)					

In relation to work experience, there are statistically significant differences in attitudes about the creation of a stimulating learning environment ($p = 0.023$) and the improvement of existing teaching models (problem-based, project-based, research-based) ($p = 0.021$). To examine the impact of three factors (up to 5 years, from 5 to 10 years, more than 10 years) on these two selected dependent variables, a post-hoc tests (Tukey HSD and Bonferroni test) were applied (Table 7 and Table 8).

Table 7. Post-hoc analysis of variations in attitudes for the creation of a stimulating classroom environment.

	95% Confidence Interval

Dependent variable	Test	WE (I)	WE (J)	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
the creation of a stimulating learning environment	Tukey HSD	<5	5-10	.312	.260	.455	-.30	.93
			>10	.551*	.201	.018	.08	1.03
		5-10	<5	-.312	.260	.455	-.93	.30
			>10	.239	.222	.529	-.28	.76
		>10	<5	-.551*	.201	.018	-1.03	-.08
			5-10	-.239	.222	.529	-.76	.28
	Bonferroni	<5	5-10	.312	.260	.695	-.32	.94
			>10	.551*	.201	.020	.07	1.04
		5-10	<5	-.312	.260	.695	-.94	.32
			>10	.239	.222	.846	-.30	.77
		>10	<5	-.551*	.201	.020	-1.04	-.07
			5-10	-.239	.222	.846	-.77	.30

*WE (Work experience)

Regarding the attitude that the metaverse contributes to the creation of a stimulating learning environment, a significant difference was found between the groups of teachers' "up to 5 years of experience" and "more than 10 years of experience" (p = 0.018 for Tukey HSD, p = 0.020 for the Bonferroni test). This difference is positive (Mean difference = 0.551), meaning that more experienced teachers' (with over 10 years of experience) rate the stimulating learning environment more positively compared to those with less experienced teachers' (up to 5 years of experience).

Table 8. Post-hoc analysis of variations in attitudes for the improvement of existing teaching models (problem-based, project-based, research based

							95% Confidence Interval	
Dependent variable	Test	WE (I)	WE (J)	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound

the improvement of existing teaching models (problem-based, project-based, research-based	Tukey HSD	<5	5-10	.341	.258	.386	-.27	.95
			>10	.557*	.200	.016	.08	1.03
		5-10	<5	-.341	.258	.386	-.95	.27
			>10	.216	.220	.590	-.30	.74
		>10	<5	-.557*	.200	.016	-1.03	-.08
			5-10	-.216	.220	.590	-.74	.30
	Bonferroni	<5	5-10	.341	.258	.565	-.28	.96
			>10	.557*	.200	.018	.07	1.04
		5-10	<5	-.341	.258	.565	-.96	.28
			>10	.216	.220	.984	-.32	.75
		>10	<5	-.557*	.200	.018	-1.04	-.07
			5-10	-.216	.220	.984	-.75	.32

*WE (Work experience)

Regarding the attitude that the metaverse contributes to the improvement of existing teaching models (problem-based, project-based, research-based), a significant difference was found between the groups: "up to 5 years of experience" and "more than 10 years of experience" ($p = 0.016$ for Tukey HSD, $p = 0.018$ for the Bonferroni test). The difference is negative (Mean difference = -0.557), meaning that teachers with more than 10 years of experience have significantly lower average ratings for this attitude compared to less experienced teachers' up to 5 years experience. This means that teachers with up to 5 years of work experience have a more positive attitude compared to teachers with more than 10 years of experience.

In relation to grade, in Table 6 are statistically significant differences in attitudes about: a better understanding of Serbian tradition ($p = 0.024$), the acquisition of procedural knowledge about making rugs ($p = 0.003$), a realistic experience of the past ($p = 0.018$), greater motivation for research on Serbian tradition ($p = 0.020$ a greater degree of individualization ($p = 0.030$), experiential learning ($p = 0.006$).

Table 9 . T-test for the difference in attitudes based on grade level (lower and upper grades)

It contributes to	Grade	N	Mean	Std. Deviation	Std. Error Mean
a better understanding of Serbian tradition	1-4	111	4.02	1.120	.106
	5-8	108	3.66	1.224	.118
the acquisition of procedural knowledge about making rugs	1-4	111	3.88	1.142	.108
	5-8	108	3.38	1.345	.129

the development of cultural identity	1-4	111	3.86	1.197	.114
	5-8	108	3.59	1.297	.125
a realistic experience of the past	1-4	111	4.14	1.156	.110
	5-8	108	3.74	1.292	.124
greater motivation for research on Serbian tradition	1-4	111	4.16	1.132	.107
	5-8	108	3.78	1.292	.124
the development of fine motor skills	1-4	111	3.03	1.449	.138
	5-8	108	2.94	1.42	.137
a greater degree of individualization	1-4	111	3.66	1.239	.118
	5-8	108	3.28	1.331	.128
experiential learning	1-4	111	3.97	1.217	.116
	5-8	108	3.51	1.279	.123
better monitoring of student work	1-4	111	3.64	1.234	.117
	5-8	108	3.39	1.252	.120
a better evaluation of student work	1-4	111	3.56	1.263	.120
	5-8	108	3.34	1.232	.119
the creation of a stimulating learning environment	1-4	111	4.05	1.163	.110
	5-8	108	3.75	1.261	.121
the improvement of existing teaching models	1-4	111	4.13	1.105	.105
	5-8	108	3.81	1.298	.125

The t-test analysis in Table 9. showed that lower grade teachers (1-4) generally have higher mean values across all categories when compared to upper grade teachers (5-8), suggesting that they hold a more positive attitude. Specifically, lower grade teachers reported that metaverse could contribute to a better understanding of Serbian tradition (Mean = 4.02) compared to upper grade teachers (Mean = 3.66). They also rated the contribution to acquisition of procedural knowledge about making rugs higher (Lower grade: Mean = 3.88, Upper grade: Mean = 3.38), and they expressed a more favorable view on providing a realistic experience of the past (Lower grade: Mean = 4.14, Upper grade: Mean = 3.74). Furthermore, lower grade teachers regard that metaverse could contribute to greater motivation for research on Serbian tradition (Lower grade: Mean = 4.16, Upper grade: Mean = 3.78) and a higher degree of individualization in teaching (Lower grade: Mean = 3.66, Upper grade: Mean = 3.28). Lastly, they rated contribution to experiential learning more positively (Lower grade: Mean = 3.97, Upper grade: Mean = 3.51).

Conclusions

Artificial intelligence has a wide range of possibilities suitable for application in teaching, which can complement a relatively new teaching model—information-development teaching—that is still in the process of being developed and applied. One of the characteristics of this teaching model is the new spatial organization and didactic-methodological equipment, bidirectional communication, and the possibility of discussion, as well as the active role of students, who become researchers constructing knowledge independently (Vilotijević & Mandić, 2016). The metaverse aims to become an integral part of education in the future, allowing students to visualize historical periods and experience immersive learning without time or spatial constraints (UNESCO IITE & NetDragon, 2023). Improving the teaching process should follow global innovations in practice but with caution due to the challenges that artificial intelligence brings. To recognize the advantages of the metaverse, such as immersive student experiences, stimulating environments, and cost-effectiveness, teachers' must develop and refine their digital competencies. Only the purposeful application of the metaverse leads to desired outcomes, such as greater dedication to the educational aspect of students, long-lasting knowledge, preparing students for the future, increased student motivation, and more. The importance of maintaining a balance between nature and artificial intelligence is recognized in addressing the health risks associated with the use of the metaverse, as pointed out by experts, as well as in raising student awareness of the purposeful use of artificial intelligence. A mixed learning environment is flexible and stimulating, supporting diverse learning styles and teaching models while encouraging the use of various applications and web tools (Ristić 2019) making it essential for children and students to continuously develop lifelong learning competencies (Mandić et al., 2024). For this reason, teachers' should be familiar with the characteristics and possibilities of applying the metaverse in working with students, as well as the associated risks. It is essential that, in addition to a theoretical approach, they have the opportunity to implement this in practice. To foster children's well-being in a technology-enhanced educational environment, it is essential to adopt a methodological approach that promotes interdisciplinary collaboration, teamwork, problem-solving, and the cultivation of children's creativity (Matović & Ristić, 2024). Given that the metaverse is still not widely used in our educational system, and the reduced awareness among teachers about terms like virtual reality, augmented reality, and the metaverse, we believe that training should be organized to enable teachers' to be practically equipped to apply these tools with students.

The results of the first research task show that, despite awareness of the existence of artificial intelligence, as well as the principles of its application and dissemination, our respondents are still the least familiar with the term metaverse, as well as what it represents (Mean=1.87). The reason for this result may lie in the age structure of our sample, but also in the fact that the application of computer-based learning is still unevenly distributed across the territory of Serbia. To effectively implement the metaverse in the future, teachers' need to be well-acquainted with the characteristics of innovative teaching models, not only in Central Serbia but also in other regions. We consider it important to note that primary school teachers of the Zlatibor district in Serbia are largely familiar with innovative teaching models, and teachers with a higher level of education are more aware of the importance of applying them in the teaching of nature and society, and are most applicable to teachers up to 10 years of age and over 30 years of work (Milenović et al., 2024).

Participants in our study believe that metaverse contributes to greater motivation for researching Serbian tradition (Mean=3.84), better evaluation of student work (Mean=3.53), creation of a stimulating learning environment (3.91), and improvement of existing teaching models (problem-based, project-based, research-based) (4.0). The application of this teaching

model supported by the metaverse, further strengthens the development of cultural identity, which our respondents also recognize (Mean=3.74).

Work experience and grade level have an impact on the formation of attitudes, whereas the amount of time spent using a computer does not exert any influence. Results indicate that more experienced teachers (over 10 years of experience) rate the contribution of the metaverse to a stimulating teaching environment more positively compared to those with less experience (up to 5 years of experience), while teachers with less experience (up to 5 years) express a more positive attitude towards the contribution of the metaverse to the improvement of existing teaching models compared to more experienced teachers. On the other hand, lower grade teachers (1-4) have more positive attitudes across all aspects compared to upper grade teachers (5-8).

Artificial intelligence cannot express emotions and cannot replace the teachers' live presence, so we believe that teachers' should be encouraged to explore it further, enabling them to successfully guide students to use artificial intelligence as an enhancement to their ideas. Given that most students are active on social media and follow digital world trends, implications for further research could focus on students as well, comparing their awareness and attitudes about the metaverse with those of teachers, and examining the current readiness of educational stakeholders to implement artificial intelligence in the classroom. Tlili et al. (2022) highlight a significant gap in metaverse research, noting that limited studies focus on early childhood, primary, and secondary education. Furthermore, no research has explored the use of the metaverse in education for students with disabilities, emphasizing the need for developing accessible and inclusive educational environments. The spatial and temporal virtual freedom offered by the metaverse has the potential to enhance inclusiveness and participation for students with disabilities and special needs. Future implications for teacher competence training include the creating of a professional development program for educators focused on the metaverse, aimed at bridging the gap between theoretical concepts and real-world applications. IT corporations should prioritize the educational aspects of the metaverse, while teachers' play a crucial role in the development of educational metaverse environments. Pilot study observations, with specific tasks on how to organize, plan, apply, and evaluate the metaverse in particular educational situations at all levels of education (from kindergarten to faculty as well as professional training courses for some professions) and especially for vulnerable groups will be essential for assessing its effectiveness.

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[1] primary school education in Serbia is divided into two cycles (1-4 grade and 5-8 grade)

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