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ORIGINAL RESEARCH ARTICLE

The outlook of learning through metaverse technology from the perspective of teachers in the science education

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As a personal avatar, Metaverse can be very effective in science, technology, engineering and mathematics (STEM) classrooms such as science classes that are practical and experimental. In this article, the aim is to report a study related to the perception of teachers and their attitudes towards the use of metaverse tools in teaching elementary science classes in Iranian education system. The study uses qualitative content analysis as well as quantitative analysis represented by descriptive statistics. The former includes of semi-structured interviews with 28 samples from two groups of pre-service teachers (inexperienced) and in-service teachers (experienced), which participants were given the opportunity to express their perceptions of Metaverse tools through interviews. The latter comprises a survey was designed to get their attitudes towards the potential use of Metaverse technology. The results showed that the nature of inexperienced 'digital native' is in line with the metaverse world and this group had relatively high confidence in using Metaverse in their teaching. Generating these new ideas requires a degree of experience that pre-service teachers do not have. However, this gap can be bridged through a group of experienced teachers who can use their experience to help inexperienced teachers understand how such tools can be integrated into practice.

Keywords: metaverse; science class; Iranian education system

Introduction

Real and virtual space interactions can shape new forms of communication, creative and social practices (Sonvilla-Weiss, 2008). The dynamic interaction between technology, culture and different sciences requires new forms and educational strategies that seek to cultivate self-centered people and cooperative, interactive and inclusive learning. In a space where there is no longer any logical difference between real and virtual space (Snelson & Hsu, 2020), forms of human–machine interaction will widely affect all issues of life. Intelligent agents (IA) and avatars are just a few examples that indicate future changes in societies (Elshan et al., 2022).

In such societies (online worlds), solving real-world problems and confronting students with these problems through different tools can improve learning potential (Orcos & Magreñán, 2018). This tools (such as Metaverse, VoiP, teleconferencing, AR and VR) can provide a close simulation of the learning experiences offered face-to-face

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in the classroom (Dwivedi et al., 2022). Nevertheless, there is still a long way to go to improve the quality and communication efficiency of these tools. In this regard, some authors have proposed problem-based learning (PBL) classes in different ways (Dharmawansa et al., 2015; Taguchi et al., 2011). In PBL, students first discuss a problem proposed by the teacher. To reinforcement their argument, they searched and gathered information to help them better understand and solve the problem. Then, they conduct experiments to complete some products, such as designing and making a small model. In the final stage, students present the necessary speeches about the results of their project and the teacher evaluates them (Barry et al., 2015).

Teaching experimental science as a PBL class is one of the concerns of the Iranian education system (Amaani Tehrani et al., 2016). As the results of the TIMSS and PIRLS tests show, the efficiency of experimental science education in elementary school is low (Martin & Mullis, 2013). Therefore, education has tried to create educational innovations in this field in every period. Today, these innovations together with technology shape the experiences of everyday life. The children in elementary and secondary levels, perhaps more than any previous generation, have many opportunities to participate in activities. These activities and experiences can satisfy their curiosity about the world through technology (Mullis et al., 2021). In this regard, Wu et al. (2013) considered the importance of using virtual objects (VO) in experimental science education and stated that simultaneous use of VO in real environments and 3D representation of invisible events facilitates the understanding of complex abstract concepts for students. This means that it is possible to capitalise on this curiosity in elementary school and guide young students on the path of systematic inquiry about the world in which they live. To respond to this request, preparing students to enter higher education in these fields is increasingly important (Aydin, 2023).

The use of Metaverse provides the possibility of realising a virtual class in an experimental way so that all kinds of class activities can be examined from different perspectives (Dharmawansa et al., 2015). A factor that has appeared today in the form of University Virtual Tours (such as classes, laboratories, residence halls and more), avatars and paying university tuition fees through digital currency. Metaverse is a personal avatar that includes all aspects of social and real-world communication – manners, personal space delineation, respect for other's opinions, dressing appropriately for the occasion and social networking (Sonvilla-Weiss, 2008). Metaverse in the STEM class, like science classes that are practical and experimental and lead to a problem, it can be very effective (Mystakidis, 2022). An example is Second Life, an online community that started its service in 2003.

Metaverse can be used a lot to test and teach experimental classes according to its type of application (Barry et al., 2009). Indeed, metaverse, in experimental classes such as science, can overcome the basic limitations of web-based 2D electronic education tools and improve the potential of learning and teaching (Mystakidis, 2022). Anderson and Rainie (2022) state that metaverse technology can cause potential problems such as academic freedom (damage to stock prices through advertising), student focus (distraction), the digital divide (access to tools) and privacy (creating a strong human digital twin). Nevertheless, metaverse will be widely used in business and education fields (Rachmadtullah et al., 2023). In this regard, given that the idea of Metaverse increased much attention in 2021–2022 because of Facebook's decision to rebrand itself as 'Meta' (Mistretta, 2022; Mystakidis, 2022). Also, because of the fact that the role of metaverse technology and similar tools (AR, VR, MR) has not been considered in the STEM education (Lasica et al., 2020; Marini et al., 2022) and especially in the

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elementary sciences of the Iran's education system, these issues have important implications for education. Because it will determine whether Metaverse and similar tools can become mainstream in education or not. It should be said that Metaverse technology, whose commercial aspects are apparently more prominent (Sriram, 2022), can become a more efficient and high-potential learning tool. In this regard, the aim of this article is to raise awareness about the effectiveness of Metaverse for STEM courses, especially science courses, so that a single perspective from the views of teachers in Iranian education system is created for science class teaching.

Study of the context

The structure of the school system in Iran is a K-12 structure that includes two 6-year periods. According to the 20-Year Vision Document (2005–2025), the educational period is divided into two primary (6 years) and secondary (6 years) periods. The secondary period is also divided into the first and second periods. After 6 years of primary education (ages 6–11), pupils follow a 3-year general education (11–14) and in the next stage a 3-year secondary education (age 14–17) (Statistical Center of Iran, 2020). The first stage is intended to ascertain the pupil's aptitude, determined by their examination grades, for either academic or the technical/vocational track in the next stage. In the second, the students specialise in one of the four areas: natural sciences, physics and mathematics, social sciences and economics or literature and arts (Aminzadeh, 2015). At the end of this stage, the students sit a national examination conducted by the Ministry of Education, and if successful, they are awarded the Higher National Diploma (High School Diploma).

Iran's educational system is influenced by the French educational system and is of a centralised type, and educational policies and strategies are controlled by the central government (Behbahani, 2010). However, movements have been to transfer parts of the power and decision-making of the provincial and city departments. Although the educational system (Ministry of Education) has increased the responsibilities of affiliated sections, decision-making is centralised and under the power and control of the central government (Nasser Takmil, 2006).

Iran has a lot of multiethnic (Persians, Turks, Kurds, etc.) and different multi-religion (Islam, Christianity, etc.) (Hasanpour et al., 2022). The field of technology and management, development and use of new digital technologies (Arkhi, 2018) has been explicitly addressed in the upstream documents of the Islamic Republic of Iran. An example of this issue is the 20-Year Vision Document (Shaffer, 2021). Nonetheless, the change in teaching methods from traditional to online education using technological software (AR, VR, MR and Metavars) has not been reflected in the educational system.

Methodology

In this research, an exploratory mixed-method was used where qualitative data are collected first and prioritised, and quantitative data are then later collected to test themes or instruments developed from the qualitative process (Creswell, 2008). This approach is most commonly used in instrument creation, wherein researchers might interview a sample of participants about a poorly understood phenomenon and then construct a survey or test based on their findings to determine how accurate their

themes were (Kimmons, 2022). In this regard, in the qualitative part, the thematic content analysis (TCA) method with a phenomenological design and in the quantitative part, a survey using the Likert scale was used to examine the views of teachers in the elementary science class of Iranian education system using Metaverse technology. The qualitative research allows attaining insight into people's behaviours, attitudes, motivations, aspirations, culture, experiences, lifestyles and even knowledge (Cigdemoglu et al., 2011). In addition, survey data helps administrators and policy makers by measure labour force participation, costs, environmental conditions and many other issues (Moser & Kalton, 2017).

Participants

According to Creswell and Poth (2016), selecting individuals who fulfill certain criteria as participants is the most suitable method of selection for a phenomenological study. Careful determination of criteria for identifying potential participants with significant experiences of the phenomenon is necessary (Cilesiz, 2011). In this regard, the participants in the present study consisted of two groups of teachers. One group comprised 12 pre-service teachers still in teacher education (inexperienced). The other group comprised 16 in-service teachers who had teaching experience (experienced). Among the inexperienced teachers, 7 were women and 5 were men. While the experienced teachers had experience between 5 and 20 years and 10 of them were women and 6 were men. In addition, in the quantitative part, among the participants in the interview process, 13 (out of 16) experienced teachers completed the survey on their experience with Metaverse, while 10 (out of 12) inexperienced teachers completed the same survey. The others only participated in the interview process and declined to fill in the survey.

Interview process

In two workshops, participants from both groups participated separately. In the first workshop, questions were asked to the participants through interviews during 1 day and as a focus group. In the morning, inexperienced teachers participated in the workshop. The reason why inexperienced teachers participated first were the questions that may arise for many inexperienced teachers. While briefly explaining the questions raised, these questions were noted down during the interviews and were asked along with other questions to experienced teachers in the afternoon. After a 1-day break, a workshop was held again, and in the morning, inexperienced teachers participated in the survey. Before the inexperienced teachers participate in the research activity (survey), a short introduction related to the questions of the previous workshop and examples of how to use Metaverse and other tools (such as the potential of AR and VR for Metaverse) were presented to them. Then, experienced teachers answered the survey questions in the afternoon.

The participants in the interview process were asked what their perception is about the potential of using Metaverse technology in teaching? And how can it help us to teach science class? Also, a sub-question was asked based on the influence of teaching experience on the ability to incorporate such tools into learning. Therefore, this question was addressed during the survey period that what are the differences in the attitude towards the potential of metaverse technology in teaching between

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Table 1. Comparison of participants' attitudes towards the potential of metaverse technology in science education.

Questions	Likert scale				
	Highly positive (5)	Positive (4)	Neutral (3)	Negative (2)	Highly negative (1)
Metaverse is an enjoyable experience					
I am keen to integrate technology into my teaching					
I am keen to take advantage of learning opportunities that can happen outside of the class					
My preferred method of teaching would be through social/ collaborative learning					
My preferred method of teaching would be face-to-face					
As a user, one can have self-confidence in technology					
I have already used Metaverse (or a similar tool) in my teaching					
I have had ideas about how I can use it in my own teaching					
I like it, but I can't see how it fits into my own teaching					
No problem, I'm just not sure it can really offer me much					
Compared to a traditional face-to-face training class, this class has a better feel					
Compared to communication in real life, communication in the metaverse feels better					

experienced and inexperienced teachers? To address these questions, while conducting an interview, a survey was also conducted and data were collected.

Data analysis

The data obtained during the interviews were analysed using the TCA method (Agabrian, 2006). TCA is a descriptive presentation of qualitative data (Anderson,

2007). For this purpose, the researcher started by transcribing and familiarising with the data to analyse the data using the thematic analysis method. After transcribing and verifying the data, the author reads the texts and notes the initial ideas. Initial ideas were used to create initial codes, which were then grouped into potential themes. Initial ideas were used to create initial codes, which were then grouped into potential themes. All retained codes were named and codes related to basic ideas in teaching science using technological methods are presented in this manuscript. Also, in order to analyse the survey in the quantitative stage, simple statistical tools such as mean and standard deviation and tables and figures were used. In this way, the average opinions of the sample were calculated separately for two groups of pre-service and in-service teachers for each of the examined items and compared in the form of tables and figures. On the other hand, it should be noted that the survey was completed at the same time as the workshops started. Therefore, these results are the teachers' initial reactions to it.

Also, to control the reliability, a Member Checking method (Charmaz, 2011) was used, based on which a draft profile of teaching science using technological methods was developed and presented to four participants to validate. The profile of teaching science using technological methods were revised based on the minor suggestions provided by the participants. In this way, the researcher tried to minimise any case of personal bias.

Ethical consideration

We would like to state that the manuscript entitled, The Outlook of Learning through Metaverse Technology from the Perspective of Teachers in the Science Education', had not undergone the Institutional Review Board (IRB) process as it is not a must in country like Iran. However, our participants' decision to participate in this study was completely voluntary and their identities were concealed. More essentially, we provided our participants with an informed consent form that they had to sign, and they were free to withdraw from participating in this study. We finally had 28 participants from two groups of pre-service teachers (inexperienced) and in-service teachers (experienced).

Findings

Based on interviews with teachers, the research findings are discussed in connection with views of teachers in the elementary science class using metaverse technology in Iranian education system. A summary of the results is provided below which subsequently proves the findings.

Qualitative analysis

In the qualitative part of the research, the findings related to the interview with the participants in two groups pre-service teachers (inexperienced) and in-service teachers (experienced) are presented in the format of Table 2.

Of the experienced teachers who had a negative response to the program, they mostly mentioned the difficulty of creating a science class experience in Metaverse. Although these teachers are regularly exposed to digital tools, they found Metaverse

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Table 2. The views of participants regarding the potential of using metaverse technology in teaching science classes.

Themes	Sub-themes	Code
The potential of using metaverse technology in science teaching	The formation of a positive attitude towards Metaverse as an educational tool	Simulation of different social activities and communication in real life
		Using similar tools to create an educational experience
		Self-confidence in technology as a tool
		Use in the practical process outside the class
	The attractiveness of activities in the learning environment	Forming a better feeling
		Enjoyable experience
		Enthusiasm in the learning process
	Active integration of technology in teaching	Promoting teaching through social/collaborative learning
		Integration in the class teaching process
		Use in the practical process outside the class

relatively complex. Another comment that came up several times was Metaverse's reliance on convenient mobile devices in the hands of students, which is not always realistic. One of the experienced teachers states that:

> It's too hard to do without mobile devices, and it's too inhibiting to use this type of technology in the science class if you don't have a mobile phone.

Another teacher states that:

> There are still some teachers who prefer to buy the hard copy rather than read the e-books (PDF) and such people who have not yet been able to communicate well even with the Internet, will find it difficult to adapt to the Metaverse.

Experienced teachers who responded positively found this program potentially motivating for students in science class teaching. They considered conditions such as 'fun', 'surprising' and 'visually attractive' about metaverse technology in science teaching. An experienced teacher states that:

> It's great to engage children in learning science through interactive participation while answering fun questions.
> Metaverse will be a great opportunity to serve experiential classes like science and create an immersive learning experience for learners.

Examples of teaching science classes in the Metaverse world show how much this technology can play a role in the spread of creativity and innovation in science classes. One of the teachers states that:

> Consider an anatomy class where students can remove and examine their own body parts instead of viewing them on a model of a human or a zoo, where students can create animals in a zoo environment with a specific style.

Similarly, inexperienced teachers responded positively to using the metaverse to teach science, for example:

> I really like it. 'I can see a future where we use this technology in the science class'.

However, when asked how they thought they could actually apply it to their teaching, they were not clear. They felt that promising was not useful and wanted to study more about it. For example:

> I feel that if I look into this program more and more deeply, I will realise that it can fit into the teaching of science and I will be more inclined to use it in teaching experiences.

Another experienced teacher states that:

> In such a world, problems should be given to students in order, and the second problem becomes more complicated, and for this purpose, it is necessary for teachers to be proficient in a living language, proficient in information technology, communication power, ability to produce content, cultural management, educational and social psychology.

Also, the metaverse forms new structures and overshadows individual and group relationships. A new experience with the interaction and combination of the world of fantasy with the real world, in which people can do things that were nothing more than a dream for them. This may interfere with some normal human activities. For example, one of the experienced teachers states that:

> Metaverse technology and similar tools raise concerns about social and cultural effects among people and causes a digital divide between rich and poor countries.

In general, new technologies force their environment to harmonise. If schools do not adapt to this reality, students will pursue education in other places that they can access. As the participants state, the reality is that it is very difficult to adapt and update with the fast-paced world of work changes. This is a reality that we have to accept and live with.

Quantitative analysis

Table 3 shows the results of quantitative Likert scale questions in the survey.

While it is not possible to draw definite conclusions from such a small data set, the above set of results can provide us with different views about the attitude and different modes of teaching among inexperienced and experienced teachers. It seems that both groups equally believed in the technology but did not know much about how to apply the metaverse technology (Figure 1).

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Table 3. Results from quantitative survey questions.

Questions	Inexperienced teachers $N = 10$			Experienced teachers $N = 13$		
	Std. deviation	Mean	*N*	Std. deviation	Mean	*N*
Q1	0.42164	4.2	10	1.16575	3.7	13
Q2	0.69921	4.6	10	0.86232	4.0	13
Q3	0.73786	3.9	10	1.33012	3.5	13
Q4	0.67495	4.3	10	0.91287	4.0	13
Q5	0.69921	3.4	10	1.18213	3.6	13
Q6	0.81650	4.0	10	1.16575	3.7	13
Q7	0.48305	4.3	10	0.89872	3.8	13
Q8	0.63246	4.2	10	1.25064	3.6	13
Q9	0.78881	3.2	10	0.80064	3.5	13
Q10	1.05935	3.7	10	0.86232	4.0	13
Q11	0.63246	4.2	10	0.75955	4.0	13
Q12	0.73786	4.1	10	0.89872	3.8	13

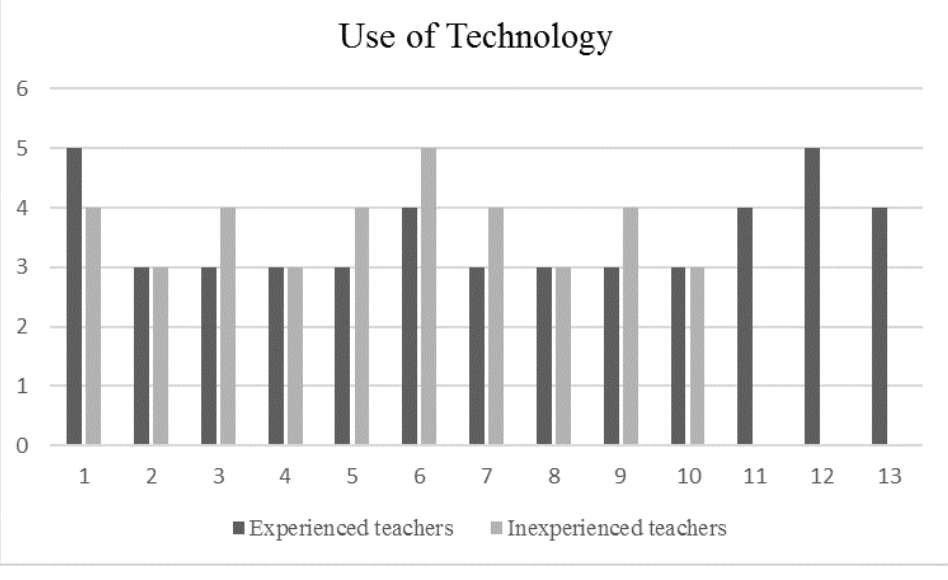

Figure 1. Questionnaire result for No 9.

Figure 1 compares the answers to question number 9 (I like it, but I can't see how it fits into my own teaching) for both groups. The results show that both groups equally like to use Metaverse technology in the class, but they do not know how to use and apply this technology in the class and find it difficult to use. Of course, it should be taken into account that the group of experienced teachers is 13 people, and compared to the group of 10 inexperienced teachers, three additional people have given relatively strong answers regarding the use of this technology in the class, which considering that the average of the group of experienced teachers is higher than the average of inexperienced teachers, this can be the reason.

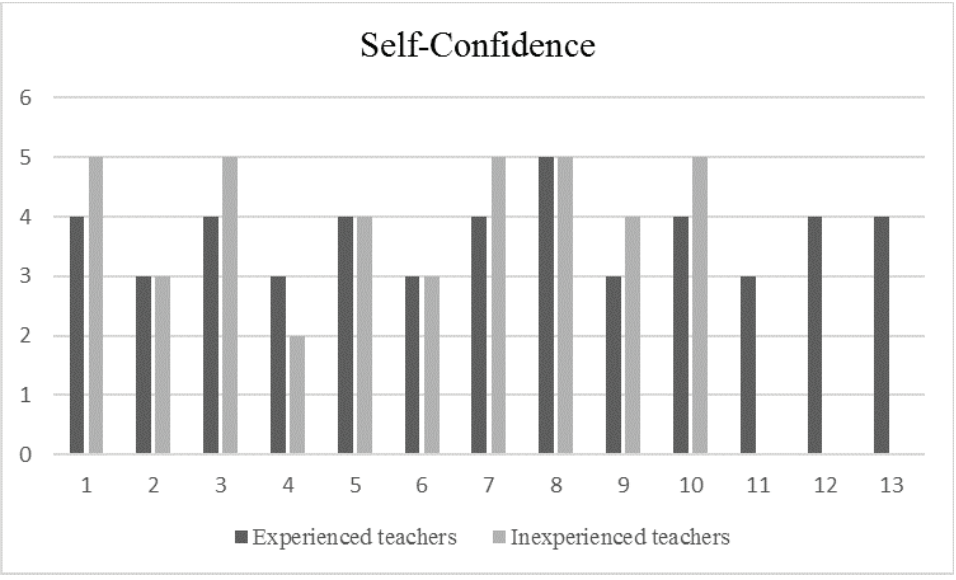

Figure 2. Questionnaire result for No 6.

Also, although all inexperienced teachers were under 30 years old and experienced teachers were three over 30 years old and 70% of them were over 40 years old, but this idea may be interesting when the results show that although experienced teachers, especially during the last 2 years because of the spread of the COVID-19, should use technology extensively in-class activities, but the research results show that they do not have enough confidence to use technology in the classroom compared to the group of inexperienced teachers (Figure 2).

Figure 2 compares the answers to question number 6 (as a user, one can have self-confidence in technology) for both groups. The results show that inexperienced teachers have more confidence to use technology in the class than experienced teachers. According to the author's impression and considering the idea that young inexperienced teachers are more 'digital natives' than experienced teachers, it can be said that this can be the reason for the answer to question 6 of the research. This is also the case in response to research question 2 (I am keen to integrate technology into my teaching), which shows that inexperienced teachers are more eager to integrate technology in the class. But it should also be considered that this nature in inexperienced teachers is probably not surprising; because they have not yet fully and directly faced the challenges of using technology in a real class and their ignorance may be the cause of this self-confidence.

In addition, the responses of both groups of teachers to other questions also show that although there is a eager and attitude to combine the real and virtual world using this technology in science class among teachers in Iranian education system, but it is difficult for them to communicate with this technology. Differences in results for the two groups may be attributed to their differences in culture, generational differences, their interpretation of survey questions or other variables. The authors feel that as participants increase their experience and time spent using technology, they will become more comfortable with operating in the metaverse world for science teaching.

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Discussion

Today, with using the 3D virtual space service called Metaverse can be used to teach PBL and experimental courses such as science class (Barry et al., 2009; Mystakidis, 2022). Looking at the views of teachers of the metaverse created by the two groups, it seems that both groups are willing to accept the opportunity to experiment.

Although the present study was based on an interview process and data collection from a short voluntary survey, it revealed interesting insights about the participants' views and their attitudes towards the integration and use of metaverse in the science class. The results showed that the potential of Metaverse technology in the science class can be divided into three categories. In this connection, the attitude of the majority of teachers from both participant groups towards the use of metaverse in the science class was positive, and they believed that simulating different activities and social communication in real life, using similar auxiliary tools to create an educational experience and self-confidence towards technology as a tool can lead to the formation of a positive attitude. The results of this part of the research reinforce the findings of MacCallum and Parsons (2019), who state that the integration of metaverse technology in learning and its use in experimental and practical subjects such as science can be very beneficial.

The results of the two groups of participants in relation to the discussion of self-confidence show that, on the one hand, this type of nature is not surprising in inexperienced teachers; because they are digital native generation who were connected with technology and can easily introduce digital learning in their classrooms. This practice has a profound effect on the generation of Millennials and Post-Millennials on shaping their attitude and interaction with their world (Nimon, 2007). Of course, the important point is that this group of teachers has not yet faced the challenges of using technology in a real classroom and it is necessary to use the experiences of the other study group (experienced teachers) in the teaching process (Lei, 2009; MacCallum & Parsons, 2019). The reason for this issue is that the training programs mainly provide pre-service teachers with the technology skills, but not how to effectively integrated technology in the curriculum (Wachira & Keengwe, 2011). On the other hand, this lack of self-confidence of experienced teachers in the discussion of using new technologies is natural, considering the nature of this generation of teachers (Generation X), because they still move on the basis of traditional learning and try to make the class teach their classes face-to-face (Batane & Ngwako, 2017; Prensky, 2001).

The results in response to the attractiveness of the learning environment also indicate that the age range and the generation gap factor can be an important factor in using this type of tool in the classroom. It is thought that trainee teachers (Generation Y and Generation Z) whose learning preferences are very important (Bishop & Wackler, 2017; Kuleto et al., 2021) are more receptive to new technologies than mature and experienced teachers, and for trainee teachers, these technologies are more attractive. Therefore, they should be given the opportunity to develop these ideas in collaboration with more experienced teachers and lead them to use new technologies. The results indicate that although the skills and confidence of experienced teachers in technology discussion may be low, but they have teaching experience and can help inexperienced teachers understand how new technologies can be integrated into teaching practice.

Also, the results show that experienced teachers point to the difficulty of creating a science class experience in the metaverse world and consider it relatively complicated. Understandably, there was caution about first understanding the program and getting more support in its use and application. However, inexperienced teachers (Gen Y and Z) are less concerned about knowing everything beforehand and are more confident about taking risks in the classroom (Howard & Gigliotti, 2016). This seems to be reinforced in the results of the research itself. It can be said that inexperienced teachers believe that new technologies bring new things with them and according to their awareness of new technologies, which stems from their previous experiences with similar tools, they try to match real life with the technological environment.

With all these interpretations, the findings of this study contradict the view of Tang et al. (2003). Researchers state that VO reduces students' attention. Also, the findings of Dunleavy et al. (2009) are in conflict with the findings of the present research. Researchers have come to the conclusion that recorded several examples of students who deviated from their original path in the play environment, which caused the students to ignore their walking environment and reduce their attention. Perhaps the reason for the contradictory findings of these studies can be seen as an additional cognitive load for students; because the incorrect use of this educational tool, such as the incorrect use of audio and video, not only increases the distraction of students in class but can also reduce the attention of students. In addition, one of the reasons for this contradiction may be the lack of attention to educational issues in the development of new software for learning environments; because by not paying attention to this, we will not achieve the desired and innovative solutions in educational environments, and new technologies are used as entertainment and not meaningful tools.

Conclusion

The purpose of this study is to investigate teachers' perception about the potential of using metaverse technology in teaching science classes and whether there are differences in the attitude towards the potential of metaverse technology in teaching between experienced and inexperienced teachers in the science class in Iranian education system or not? Although this study was based on a very small number of participants (only 23 responded to the survey), the findings provided us with insights and attitudes about the questions. One finding that reinforced previous findings in the literature was that inexperienced 'digital native' teachers had relatively high levels of confidence in using this type of tool in their teaching and their attitudes were positive, but older and more experienced teachers were less confident. However, experienced teachers could use their experience to help inexperienced teachers understand how such tools can be integrated into practice.

Although this research was interested in constructive and experimental learning using possible tools, it was limited because of factors related to qualitative and quantitative data. These results suggest some areas where future research may usefully focus. In particular, we need the application of metaverse software in the educational structure of science courses so that the results of the current research can be strengthened empirically and through experimental results, which will be considered by the authors of the current research. The structure of the present study effectively enables us to know the attitude of teachers towards this type of technology and in future studies,

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consider the learning content, theories, and underlying mechanisms of learning that may uniquely explain the metaverse learning experience. To do this, we need to work not only with the teachers but also with the students in the school; because creating self-confidence, enthusiasm to use this type of tool and the teacher's skill in using Metaverse and its tools is only the first step in using this tool to enhance learning.

Availability of supporting data

Data generated or analysed during this study are available from the author on request.

Competing interests

The author declares no competing interest.

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