IBAD
SOSYAL BİLİMLER DERGİSİ
Journal of Social Sciences

Özgün Araştırma / Original Research

IBAD 2026 (20): 1-18

https://doi.org/10.21733/ibad.**1807649** **OPEN**

Innovative Approaches to Language Teacher Education: The Metaverse

Dil Öğretmeni Eğitiminde Yenilikçi Yaklaşımlar: Metaverse

Tolga Çıtak[1*]
Gülden İlin[2]

ABSTRACT

This study contributes to the professional development of English language teacher candidates by enabling them to experience micro-teaching lesson study cycles implemented within a metaverse environment. The collaborative teacher development model, which has been practiced in schools for some time, was integrated with micro-teaching practices and structurally adapted to suit the dynamics of a virtual metaverse setting. Employing a case study design as part of qualitative research methodology, the study involved five English language teacher education students enrolled at a public university in Türkiye. Data were collected through semi-structured interviews, observation notes, and group discussions, and were analysed qualitatively; the emerging themes and codes were interpreted by the researcher. The findings indicate that the pre-service teachers gained teaching experience within the metaverse environment and enhanced their awareness of online instruction by discovering creative ways of delivering lessons unique to the virtual space. In addition, participants articulated the strengths and weaknesses of transferring distance education into the metaverse and demonstrated a critical perspective toward its improvement. Furthermore, the results of the study offer a more comprehensive model for distance education as an alternative to current AI-driven approaches, pointing to a more feasible option in response to existing critiques of online education in the literature.

Keywords: Metaverse, Virtual Environment, Lesson Study, Microteaching, Preservice English Language Teachers

ÖZ

Çalışma kapsamındaki bu araştırma İngilizce öğretmenliği bölümü öğrencilerinin, metaverse evreninde uygulanan mikroöğretim ders araştırması döngülerini deneyimleyerek mesleki gelişimlerine katkı sağlamaktadır. Bir süredir okullarda uygulanan işbirlikçi öğretmen gelişim modeli, mikroöğretim dersleri ile harmanlanmış ve metaverse sanal evrenine uyum sağlayacak şekilde yapısal değişiklikler uygulanarak kullanılmıştır. Çalışmada nitel araştırma yöntemlerinden örnek olay incelemesi kullanılarak, Türkiye'de bir devlet üniversitesinde eğitimlerini sürdüren beş İngilizce öğretmenliği öğrencileri katılım sağlamıştır. Veriler yarı yapılandırılmış görüşme, gözlem notları ve grup tartışmasından elde edilmiş, nitel veri analizinden geçirilerek ilgili temalar ve kodlar araştırmacı tarafından yorumlanmıştır. Çalışmanın sonucunda aday öğretmenleri metaverse sanal evreninde öğretmenlik deneyimi elde etmiş, sanal evrene özgü yaratıcı sunuş yolları keşfederek sanal alemde çevrimiçi eğitim ile ilgili farkındalıklarını artırmışlardır. Bunun yanı sıra, katılımcılar sanal evrene taşınan uzaktan eğitim modelinin güçlü ve zayıf yanlarını ifade etmiş, geliştirmeye yönelik kritik bir bakış açısı sundukları gözlemlenmiştir. Ayrıca çalışmanın sonuçları günümüzde yapay zekâ yönelimine alternatif olarak daha kapsamlı bir uzaktan eğitim modelini sunmuş, alanyazında mevcut çevrimiçi eğitime yönelik eleştirilere karşın daha uygulanabilir bir seçeneği işaret etmiştir.

Anahtar Kelimeler: Metaverse, Sanal Evren, Ders Araştırması, Mikroöğretim, Aday İngilizce Öğretmenleri

[*] **Sorumlu yazar / Corresponding author**
[1] National Defense University, Balıkesir, Türkiye, E-mail: tolga.citak@msu.edu.tr **ORCID:** https://orcid.org/0000-0001-8771-2497
[2] Çukurova University, Education Faculty, Adana, Türkiye, E-mail: guldenilin@cukurova.edu.tr **ORCID:** https://orcid.org/0000-0003-1798-6956
Başvuru/Submitted: 21.10.2025 **Kabul/Accepted**: 29.07.2026
Turnitin Similarity Index 07%

Çıtak, T. & İlin, G. (2026). Innovative approaches to language teacher education: The Metaverse. *IBAD Sosyal Bilimler Dergisi-IBAD Journal of Social Sciences*, (20), 1-18. https://doi.org/10.21733/ibad.1807649

INTRODUCTION

The rapid pace in development and societal changes has continuously compelled human beings to adapt to the ever-changing world. The changes do not consist of just competing with the growing technological enhancements but also changing our routines in many fields such as marketing, healthcare, and education. Hence, crucial changes in the profiles of the 21st century students require more competent and contemporary approaches. However, it is almost impossible to expect teachers to adapt the blazing speed of the technological advancements via simple directions. Rather, meaningful opportunities are necessary to understand the characteristics of the new-era students with available technology and reflect on their present practices, the way how students learn, and the subject matter itself (Ball & Cohen, 1999). In this respect it is vital to meet the needs of the digital natives as Prensky (2001) has defined and prepare prospective teachers for the digital world who are able to benefit from technology effectively.

Modern teacher education nowadays is no longer concerned solely with what teachers are expected to teach, rather which pedagogies, strategies, and methods are used to construct student knowledge (Kosnik et al., 2018). Especially in a world of rapidly changing lifestyle, evolving technology, and growing student demands, it is necessary to guide students through the sheer amount of information that is accessible via several mouse clicks to everybody. Furthermore, teachers of modern classrooms are responsible for designing appropriate learning environments where students are able to construct knowledge on the basis of the surrounding information (Schleicher, 2020) through meaningful interaction with peers and technology. Within this new paradigm, technology cannot be considered merely as an instrument to transfer knowledge but needs to be acknowledged as an integral component for instructional methodologies. Hence, Technological Pedagogical Content Knowledge (TPACK) emerges with expecting teachers to create a foundation for effective teaching with technology and to understand the ways of presenting subjects through technology (Mishra & Koehler, 2006). However, in the era of artificial intelligence and immersive technology, researchers have called for extending TPACK and adapting into the new world by naming it Artificial Intelligence Pedagogical Content Knowledge (AIPACK) which expects educators to critically analyse, understand, and apply futuristic technology, AI tools in particular, in teaching and learning environments (Zawacki-Richter et al., 2019; Holmes et al., 2019). In this respect, teachers of today's learners must develop an understanding of AI and immersive technology and integrate them into the instructional strategies constructed with experience and knowledge from the field. That is, teachers are required to understand such the potentials and limitations of these technologies, as well as the integration into pedagogy (Ning et al., 2024).

Moreover, it is necessary to critically consider the emotional as well ethical limitations of future teachers. In terms of the AI-era, research shows that teachers are expected to demonstrate advanced level of competence in technology use. However, in such technologically surrounded teaching environments, teachers question their necessity due to sheer number of possibilities provided by AI. On the other hand, AI is criticised in regard to its "socio-emotional capacity", which emphasises the need for real teachers who remain human connection, emotional bond, an empathy (Oh & Ahn, 2024). Concordantly, teachers are even expected to take more responsibilities than ever before: integrating technological enhancements into instructional practices and fostering collaboration and preserving social and emotional connection among the individuals. Herein, it is important to provide teachers necessary support in their evolving roles and create teacher education programmes with the intention to train teachers on cognitive, emotional, and ethical level by including sufficient technical skills to keep up with the latest

trends in educational technology and to be ethical decision-makers in regard to selecting appropriate technology (Daher, 2025) to meet the evolving needs of contemporary learners. Beyond, the remaining gap between research and practice causes teachers to remain on theoretical level without being able to reveal concrete evidence. Therefore, teachers are in urgent need to change their roles to producers of educational products and methodologies through experiments and research rather than limiting them treating them as consumers in the field of education (Cochran-Smith & Villegas, 2015).

Although professional development approaches such as microteaching and the Lesson Study (LS) have been implemented to enable teachers and educators to exchange ideas regarding effective teaching practices and useful ideas, address student learning needs, and support teachers in collaborative planning, collaborative discourse, and reflection (Kotelawala, 2011; Qin, 2024), it is clear that these approaches require adaptation to fit into the digital world of today and provide present teachers as well as prospective teachers with the necessary support. Nonetheless, LS still remains distinctive for its ability to conduct live research lessons that has been defined as a collaborative professional teacher training model where participants jointly plan, teach, observe, evaluate and revise research lessons in a cyclical process (Ding et al., 2024; Lewis et al., 2019; Takahashi & McDougal, 2016). Moreover, Murata (2011) underlines the opportunities of live research lessons which remain rather authentic and foster various facets of the teaching practice.

However, along with the Covid-19 outbreak educators and researchers have been discussing online or distance education that has primarily occurred as an immediate solution. Particularly during the lockdown, educators were able to sustain teaching and learning activities but soon faced social and psychological challenges due to the nature of the available technology (Barth et al., 2010; Heffner et al., 2011). Since conventional communication platforms have been used to compensate the difficulties of face-to-face meetings, further wars, disasters, and other reasons ignited many debates on the social perspective of the available technology. In regard to Language Teacher Education (LTE), many scholars further put forward that the practical components of teacher preparation that were disproportionately affected (Chasciar et al., 2025).

Along with the global changes, LTE has undergone several changes to meet the needs of globalisation with the discussion of researchers, specialists, and national educational authorities (Richards, 2008). Within this context, digital advancements have found their way into teacher training programmes offering preservice teachers to collaboratively benefit from technological developments and transform teacher training (Minea-Pic, 2020). There is no doubt that LTE must provide meaningful opportunities for preservice teachers to develop effective teaching and learning practices which have been acknowledged as a path for teachers to critically examine theories and track their own process of professional development through collaborative methods, teacher research, and ongoing in-service training (Crandall, 1993, 1994, 1996; Darling Hammond, 1994; The Holmes Group, 1986). Among these appraches, microteaching has been a significant part of LTE programmes enabling teacher candidates to test and critically evaluate their own theories and methodologies and transform received content into classroom practice (Hilliker, 2020).

As microteaching and LS share the same aim of fostering both prospective and in-service teachers to develop knowledge and practice according to recent educational reforms, blending the two models to benefit from both has occurred as Microteaching Lesson Study (MLS) to minimise the length of the LS procedure and preserving its collaborative and reflective nature to experience the complexities of authentic teaching practices within a simplified setting (Benton-Kupper, 2001). Susilo (2015) defines MLS as a process that enhances teachers'

professional competencies to enhance the quality of lessons and student learning collaboratively. Moreover, Grossman, Hammerness, and McDonald (2009) underline the necessity for frequency practice of prospective teachers to engage in focused opportunities, experiment with instructional strategies, and then learn from the outcomes (pp. 189-190). In this respect, MLS is designed similar to LS encompassing the steps of selecting an overarching goal, preparing research lessons, participation of an expert, and finally critically reporting the outcomes (Fernandez, 2009).

In this context, researchers and educators have started to investigate the possibilities of implementation of LS sessions and microteaching in online environments using communication platforms such as Teams, Zoom, or WhatsApp. However, the immense speed of technology and continuously evolving expectations of learners show that conventional methods have been appearing dull to the digital descendants. Hereby, it is necessary to prepare future teachers with necessary skills and technology to be prepared for the negative conditions in the world and can develop backup plans to use a variety of communication platforms to stay to remain contact and support collaboration using virtual study groups (Gichuhi, 2025). Furthermore, researchers have been further encouraged to conduct studies on immersive virtual environments, including the metaverse, as a means of providing extended teacher collaboration beyond the limitations of traditional communication platforms.

The metaverse, which was originally conceived to provide platforms for entertainment (Sullivan, 2021), has been on the radar for many companies to adapt educational activities into the virtual world. The metaverse can be defined as persistent three-dimensional virtual reality encompassing daily activities that are performed through the control of avatars. Nevertheless, when compared with the conventional platforms, the metaverse offers unique abilities that might find solutions to the discussions in terms of socialising and psychological well-being. Considering the 21st century learners, games, social media, and virtual worlds play almost an equal role in their lives as their real one (Lin et al., 2022) which makes them familiar to the online world they live in most of the time.

Accordingly, many scholars have begun to investigate the outcomes of online learning and the metaverse since it has been frequently mentioned (Zhu, 2022). Technology companies and educational start-ups have also begun to create learning environments to support individuals in several school subjects including history, science, and foreign language learning. Despite the many opportunities, teacher education has not been approached in particular which makes the present study an opportunity to investigate the outcomes of shifting collaborative models that are conducted in real environments into the virtual world. Although scholars have conducted studies on integrating MLS into digital environments, the studies remained on using communication platforms to investigate the outcomes of collaborative models. For instance, Subasman (2024) explored the integration of LS model into online learning platforms in which the results revealed that the digital tools provided a deeper understanding of the lesson study experience enabling further sources and multiple online communities. In this regard, the online implementation of MLS or Online Microteaching Lesson Study (OMLS) has been only investigated in the scope of transferring the model into communication platforms that have been criticised through the Covid-19 pandemic. De Almeida and Weber (2025) investigated the effects of a microteaching model carried out online which has been revealed as a practical opportunity for preservice teachers to develop the competencies required of 21st-century educators. Besides, Bekereci-Şahin & Aslan (2026) revealed positive outcomes when conducting microteaching online which provided not only necessary practice opportunities but also fostered digital literacy of students and increased their confidence in using online instructional approaches.

In this respect, the present study was designed to relocate the physical campus into the virtual environment by implementing OMLS in the metaverse. Moreover, it was aimed to make online/distance education appealing to the digital natives who have grown up in technology-rich environments. Further, the metaverse offers considerable protentional in supporting prospective teachers in terms of fostering professional growth and providing opportunities to practice teaching and confront challenges prior entering real classrooms. From this perspective, this research aims to investigate the implementation of OMLS in the metaverse from the perspectives of preservice English language teachers and is framed by the following research questions:

1. How do the student teachers evaluate the experience of the OMLS in the metaverse as research lesson teachers?
2. How do the student teachers evaluate the experience in the OMLS as students of the research lessons?
3. How do the student teachers compare microteachings in the real classroom with virtual ones?

METHOD

The present study, which aims to explore preservice ELT teachers' perspectives on the relocation of OMLS into virtual environments, used a qualitative research methodology and case study design. The chosen design enables the researcher to explore a real-life case over time by including multiple sources of data and report a phenomenon observed (Creswell, 2013). Moreover, case studies provide holistic descriptions and analysis of events or phenomena (Younas & Inayat, 2025) to gain extensive knowledge about the occurring actions and reflections throughout the whole study.

The metaverse software "Universe" was selected to provide a platform that can be used to conduct the OMLS process with the preservice ELT teachers. "Universe" that has been used to conduct the present study is a platform developed by the company "ViewSonic" which considers the software as an innovative platform to conduct real-life-like lessons online promoting the social facets of physical education environments in the metaverse era. Besides, the software enables users to create avatars and benefit from a variety of gestures and facial expressions enabling students in particular to show emotions and feelings to other users of that platform. Moreover, the software comprises multiple teaching and learning environments including smartboards, desks and chairs, as well as customisable posters and 3D objects. The rationale behind opting for this particular software lies in the abilities that the users are provided with and the fact that this platform has been designed to conduct online/distance education.

Moreover, the platform is designed around social-constructivist principles emphasising the collaborative knowledge construction and experiential learning integrated within the metaverse environment. Furthermore, the participants are provided with opportunities to engage in meaningful communication, collaborate with peers, and task-based activities, thereby fostering social presence and integration to a broader extent that is mostly not available in traditional communication platforms.

In this respect, the participants were responsible for observing, planning, teaching, discussing, and reflecting during the research cycles which enabled the majority of the group to assume the role the teacher in each research lesson. The researcher primarily focused on guiding the student teachers during the study providing sources if necessary.

Sample

In accordance with the scope of the research, purposive sampling method was employed to select the participants whose could provide rich and relevant insights into the phenomenon. The rationale for this strategy was to enhance the depth of the understanding (Palinkas et al., 2015) and to obtain accurate information regarding the outcomes (McMillan & Schumacher, 2010). Hence, the present sampling method distinguishes itself from selecting participants randomly but ensures that specific cases are present in the final sampling of the research (Campbell et al., 2020). The participants were selected from the English Language Teaching Department at Balkier University, who had recently begun their year of undergraduate study. Five prospective ELT teachers volunteered to participate in the OMLS process by ensuring no teaching practice and basic competence in using computers. Since the curriculum of the department provides practicum sessions in public schools in the last year of their education, none of the participants had previously engaged in teaching practice either at the university or in schools. The following table presents the demographic information of the sample group.

Table 1. *Participants (n:5)*

Student Teachers	Age	Department	Teaching Experience
Participant 1	22	ELT	No Experience
Participant 2	22	ELT	No Experience
Participant 3	21	ELT	No Experience
Participant 4	21	ELT	No Experience
Participant 5	21	ELT	No Experience

A qualitative case study was considered appropriate since the aim of the present study is to reveal in-depth information in regard to teaching experiences in the metaverse era. Besides, the details of the participants including age, department, and teaching experience are presented in the table.

The participants received a series of theoretical training introducing the OMLS process before starting with the practical phase. Further, the preservice teachers collaboratively decided upon an overarching goal to fulfil, the units to teach according to the curriculum of the ministry of national education (MoNE) and developed lesson plans in order to meet the needs and interests of 21st century students. The practical part of the study commenced with a pilot study to provide participants opportunities to become familiar with the metaverse platform as well as the OMLS process. Additional research lesson cycles were conducted allowing the preservice teachers to engage in the whole OMLS process throughout the study.

Following the completion of the pilot study, the participants agreed on developing lessons based on middle school English lesson units and further conducted meetings to discuss and revise the lesson plan according to the shortcomings recorded in the research lesson cycles. In the final cycle, the student teachers created a comprehensive lesson plan in accordance with the diversity of the viewpoints and feedback from both parties, the research lesson teacher and the research lesson students.

Data Collection Tools and Analysis

The data in the present study were collected from multiple sources enabling the researcher to triangulate and comprehensively understand the phenomena. The sources included transcriptions of lesson planning meetings and post lesson discussions, field notes, collectively written lesson plans as well as reflective journals. The variety of data sources enabled the researcher to compare and contrast the experiences not only among the individual participants

but also enabled a clear comparison of the members experiences across the different stages of the OMLS process. Thereby, multiple sources enable the researcher to reveal insights by completing each other and provide a better understanding of phenomenon (Smit et al., 2021). In this respect, the wide range of data sources offered a deeper insight into the experiences, perceptions, and attitudes of the participants.

The audio-video recordings were transcribed verbatim and subsequently analysed using qualitative data analysis software. The sample group was free to use both their native language and English to express their experiences in detail and allow the researcher to pay further attention to the outcomes.

In order to clearly portray the outcome's, initial coding process was conducted to reveal the themes that meet the research questions. Moreover, additional meetings were held with the participants in order to conduct member checking enabling the researcher to cross-check the codes with the excerpts to enhance the trustworthiness of the coding process. Hence, the code list was further revised and similar codes were eliminated or blended to provide a more coherent and analytical robust code book that again was presented to the study group to minimize potential misinterpretations. Since validity is critical in qualitative research, the member checking process helps to reduce misinterpretations and enhances the link between propounded perspectives and analysed data (McKim, 2023). Table 2 portrays the revised codebook comprising 26 codes and 5 themes, namely learning environment, the research lesson in metaverse, the research lesson teacher, the research lessons students, and the Universe application. Moreover, to provide a clearer understanding, the codes have been categorised as positive and negative to enhance interpretation of the participating students' perspectives.

Table 2. *Codebook*

Themes	Positive Codes	Negative Codes
Learning Environment	Arrangement of the environment	Technical Difficulties Authorisation of teacher and students
The Research Lesson in Metaverse	Real-life-like experience Innovative lesson planning Lesson planning and implementation Meeting the objectives Competitive lesson Effective lesson	Time constraints Mismatch Technical constraints
The Research Lesson Teacher	Teacher motivation Effective use of functions Managing classroom Guiding students	Preparation Teacher anxiety
The Research Lesson Students	Student motivation Student engagement	Disruption Background knowledge
The Universe Application	Innovative	Required training Required equipment Face-to-face preference

Further, a clearer presentation of the revealed codes and themes were presented with a mind-mapping software to present the deduced results.

Ethical Statement

The ethics committee approval of the thesis from which the article was produced was obtained from Çukurova University Ethics Committee with the decision numbered E-838991 on 31.10.2023. Informed consent was obtained from all participants, and they were provided with detailed information about the purpose of the study, its methods, potential risks, and their rights.

FINDINGS

The findings related to the first two research questions in regard to the evaluation of OMLS in the metaverse by the participating students and the research lesson teachers are presented via the excerpts of the participants supported by figure 1 below.

Figure 1. *Themes and frequent codes regarding to the OMLS evaluation from the viewpoint of the research lesson teacher and students.*

As demonstrated in the figure, the research lesson teachers emphasised the increase of motivation during the research lessons that also has been highlighted in the excerpts of the participants. The following excerpts of two participants underline the motivational increase as teachers of the research lesson.

Participant 2

The opportunity to act like a real teacher in a real classroom increased my motivation and I felt encouraged to teach my students in the classroom.

Participant 5

I am very happy to see the effect of many different opinions and perspectives in the cycles. The LS method helps to develop my teaching skills. I feel motivated when my friends tell me the positive and negative things in my teaching.

For instance, Participant 2 expresses his/her motivational increase affecting his/her self-confidence in the teaching practice. On the other hand, Participant 5 underlines his/her pleasure in terms of the experiencing OMLS process. Moreover, he/she emphasised his/her pleasure in terms receiving different perspectives during the research lesson cycles fostering the instructional skills. Besides, the collaborative intention of this model provides higher motivation through supportive peer interactions.

When considering the second research questions and the perspectives of the participating research lesson students, the figure above clearly displays the strong bond between student motivation and student engagement. It is clear that higher motivation opens paths to further engage with the classroom subject and provides effective learning and student outcome.

Participant 2

I felt very active during the lessons although my role was to be sixth grade student. I couldn't realize how fast the time was over. I literally had no time to get bored because I was motivated to join the activities.

Participant 4

Using an avatar might be the greatest idea in this whole teaching process since students often associate avatars they created with themselves.

As such, participant 2 underlines his/her positive experience during the research lessons as a student and emphasises his/her active participation. Moreover, he/she sheds light on the positive side effect of not realising how fast the research lesson was over since high motivation and engagement hindered boredom and disruptive behaviour. On the other hand, Participant 4 revealed positive experience on the use of avatars and opportunities to identify with their avatars.

Furthermore, both the research lesson teachers and the students emphasized the real-life-like experience (as seen in Figure 2) enabling the first encounter of authentic teaching in the virtual world. Herein, the metaverse enables prospective teachers to test and evaluate instructional strategies, methods, and techniques before taking a concrete step into real classrooms in a simulated environment.

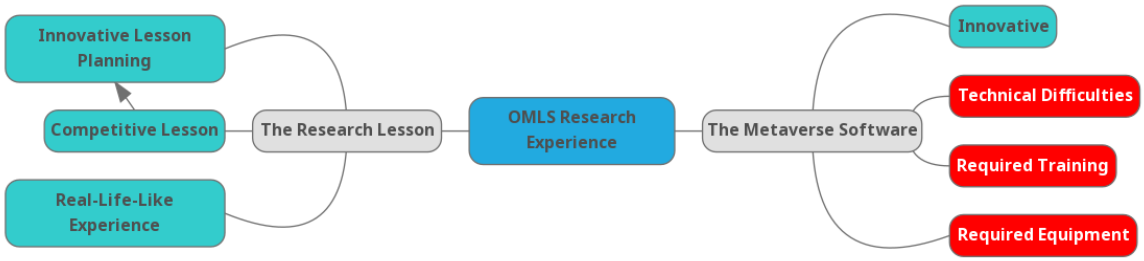

Figure 2. *Themes and frequent codes regarding to the evaluation of OMLS in the metaverse.*

In addition, the opportunity to design innovative lesson plans enables both teachers and students to join immersive educational contexts comprising activities and environments that are not possible to conduct in the real world. In this respect, the following participant emphasises the innovative opportunities that are available in the Universe application.

Participant 2

We could arrange the classroom based on the topic. For example, there was a forest classroom. We could design the class environment according to the subject matter and provide something which is not possible in real life.

Participant 2 reported that the study group was able to arrange the virtual classes according to the activities they had decided upon which would not be able to master in real classrooms. Opportunities were present to include models and items that are either not possible to accommodate in physical rooms or not possible to see with the naked eye.

However, as Figure 2 displays above, the student teachers also emphasized the shortcomings of conducting microteaching sessions in the metaverse such as technical faults which have appeared during the research lessons. In this respect, in order to overcome technical difficulties and benefit from the technical enhancements effectively, training regarding to the metaverse software is necessary.

Participant 1

I quickly realized that people need a kind of training before attempting such online class because it is totally different from the normal online classes via Teams or Zoom.

Participant 1 expresses this shortcoming by underlining the necessity of a training course before using the metaverse software as it clearly distinguishes it from conventional online classes held via Teams or Zoom. Besides, Participant 5 indicates that up-to-date hardware is required to fully experience the real-life-like atmosphere through high-resolution graphics. He/she also emphasises that lags during the lessons might cause boredom or prevent engagement in the activities.

> Participant 5
>
> *You definitely need good hardware. Because even some minor lags can cause boredom and prevent engagement. Like gamers or streamers, this programme can be perfectly used with good computer and two monitors.*

Nevertheless, despite the several drawbacks experienced during the study, both students and teachers of the research lessons positively expressed their experience in the metaverse commonly underlining the fact how fast the time passed during the lessons although most of the participants harboured negative perceptions of online/distance education due to the prior experience during lockdown. In this regard, it is clear that the identified positive aspects are closely interconnected which reveals the innovative virtual world that enables users to create creative lessons plans which as a consequence motivates students and teachers in the gamified or competitive atmosphere.

In line with the third research question, the participants were expected to compare real microteaching sessions with virtual ones. As Figure 3 depicts below, the outcomes were again coloured in terms of positive and negative experience that the participants put forward after the OMLS process.

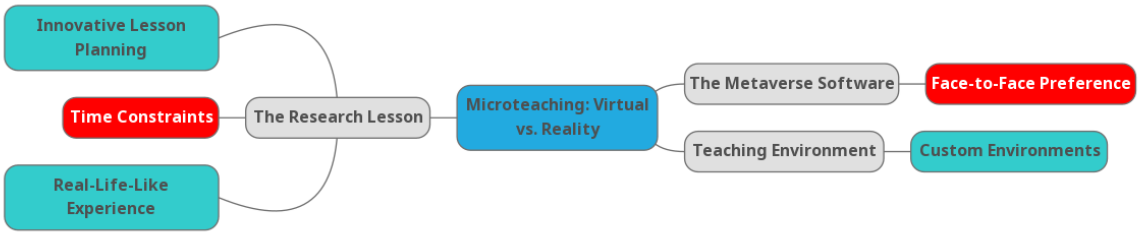

Figure 3. *Themes and frequent codes regarding to the comparison between virtual microteaching and real microteaching.*

Considering the excerpts of the participating student teachers, it is evident that the innovative aspect of the metaverse and the real-life-like experience have been positively stated. For example, Participant 3 in his/her excerpt stated that conventional online classes caused boredom since the students remain merely passive and are just listeners of the instructing speaker.

> Participant 3
>
> *I have experienced online education during my prior semesters. Unfortunately, it was not very effective because we were only able to join online meetings and listen to our lecturers. This caused immediate boredom and sometimes we left the classes or turned our camera off. In simple words, we were just passive listeners.*

However, as the following student teachers highlighted, the metaverse enables active participation despite the fact the lessons are held online and provides active engagement. Moreover, students are expected to take responsibility in the virtual classrooms via passing

set activities or collaborative work. Besides, the software enables individuals to think outside the box and create innovative lesson plans that without doubt are not possible to conduct in the real world. Participant 3 for instance emphasises the opportunities to design the virtual classes according to the desired needs and interests creating a more competitive learning environment where students can actively engage in the activities.

Participant 3

This project is a good alternative for distance education because common programs do not give the chance to engage fully in the lesson. Both teachers and students can actively join the classes and I saw that the motivation is very high.

Participant 2

We could arrange the classroom based on the topic. For example, there was a forest classroom. We could design the class environment according to the subject matter and provide something which is not possible in real life. Also, the games we integrated were really enjoyable and all the students tried to reach the highest scores.

On the contrary, as it is provided by Participant 4, although the technological enhancement enables users to design and create environments through a few mouse clicks, the planning and designing of effective lessons and environments remain time consuming as in the real world.

Participant 4

I think we underestimated the difficulties of creating effective lessons because it was easy at first to add activities or materials to the application. However, after the pilot study we have seen how seriously a lesson plan must be developed to meet all objectives. So, as in real life, developing good lessons are similarly time consuming.

Again, the unlimited possibilities require a clear definition of the objectives and precise selection of the activities in order to create an effective lesson. In this respect, although conducted online, the planning phase as well as creating the virtual environments requires necessary time and effort in order to meet the learning objectives.

As it is demonstrated in Figure 3, "face-to-face preference" indicates that prospective teachers still opt for real microteaching sessions due to the nature of the profession. Participant 2 underlines his favour for computers and technology but still prefers to teach in real classes.

Participant 2

Although I like computers and advocate such innovative technology, as a teacher I would definitely prefer face-to-face over online or virtual classes. It is nice to see how far we can go with such applications but replacing real classes is impossible, I think.

However, the participant positively expresses the experience of the metaverse by seeing how far teachers can go beyond the limits of online education with such applications. Also, the rest of the preservice teachers emphasise their preference for real classrooms and illustrate the following statements.

Participant 5

It attracts more interest compared to other online education methods. But I need to be in physical environments. I want to see, hear, touch, and smell all the things. I would choose face-to-face over online classes as well.

Participant 1

> *This is the best second choice. If it is not possible to conduct face-to-face classes I would choose this option.*

Overall, the findings indicate that the participants positively reported their experience in the study and in the metaverse environment. However, the new technology was generally reported as complementary rather than a primary option for teaching especially when face-to-face instruction is not feasible.

RESULTS AND DISCUSSION

The present study aimed to investigate prospective ELT teachers' perspectives on the relocation of microteaching into the metaverse. In order to reveal the perspectives, the study group contributed to a three-cycle OMLS process that has been conducted in the virtual world where they have encountered initial teaching experience prior to their practicum periods. It has been found that the shift into the virtual world has been positively experienced. The teachers of the research lessons show high frequency in teacher motivation emphasising the innovative solution to online classes. Besides, the results display the common attitude towards conventional online education conducted with tools which unlike the metaverse significantly hinders active participation and reduces teacher motivation. In more recent times, online courses conducted online have been reported as not motivating, not meeting the academic needs, and not enabling students to be a part of the lesson or the university (Akdemir & Kılıç, 2020; Flores et al., 2024; Potter et al., 2025). The data clearly underlines the boundaries of the existing communication platforms enabling users to share common computer files only whereas the metaverse enables teachers to act like in real classrooms and hereby support instructional skills and pedagogical knowledge.

On the other hand, the findings suggest interactive and competitive learning increases student motivation and realistic classrooms further foster social engagement despite conducted online. As the participants emphasise, the real-life-like learning atmosphere draws significantly more interest than conventional communication tools and the fact that being able to use additional gestures enhances positive emotions linked to active participation, social interaction, and belonging to one's community. Dusen & Otero (2014) assert that connection or belonging of students into social settings affect to what extend they integrated with their environment. Besides, Bohndick et al. (2025) emphasise the necessity of belonging in the classroom and further puts forward that it needs to be considered as a foundation for well-being, motivation, and academic success. These findings are noteworthy as it is necessary to remember that conventional platforms were exposed to heavy criticism in terms of students social and psychological well-being. For instance, Derakhshandeh & Esmaeili (2020) reported that a large number of students experience difficulty in terms of feeling isolated from their peers or disconnected from their social environment when exposed to online education since the used platforms lack in enabling interaction with the community. In this respect, the present study display how student achievement can be affected though effective communication and social interaction. An increase in student outcomes has been recorded since a strong link among success, self-confidence, and motivation has been present resulting higher student contribution to the lesson content (Jacobsen, Eggen & Kauchak, 2002). Moreover, students had the opportunity to take responsibility acknowledging them as active members of the lessons. In this context, high engagement combined with high motivation significantly increases student achievement and prevents the students from losing focus (Renzulli, 2021).

Although the results reveal several technical challenges experienced during the OMLS process, the real-life-like experience and the sophisticated opportunities of such technology have been

acknowledged by the study group who emphasised the advantages compared to conventional online classes. Furthermore, the collaborative planning and reflection upon the lessons and teaching practices have been underlined as a valuable experience that positively affected student teachers' professional improvement. It is critical to know that learning from teaching is a significant indicator of successful teacher education (Sims & Walsh, 2009, p.732) in which prospective teachers apply and critically assess their acquired knowledge.

Despite several technical limitations and the required training stated by the participants, the results clearly depict the enjoyment of such technology creating futuristic lessons that are collaboratively developed which as a result fosters creativity and enhances necessary skills for the profession (Ventista & Brown, 2023). Moreover, the results indicate a strong link between the knowledge learned at the faculty and the research lessons in which the students critically reflect on their own teaching strategies.

However, although the student teachers generally acknowledged the replacement of conventional online education methods through the metaverse, a preference for face-to-face teaching has been the primary choice. Herein, this result can be interpreted as the nature of the profession requiring not only competence in the relevant subject, but also the social aspects that are part of the profession as a teacher. As a consequence, these kinds of technological enhancements are developed to support teaching and learning whereas professional teachers are trained not only to deal with the study subject but also to deal with individuals' learning procedures (Shulman, 1986) as well as social and emotional concerns. However, the metaverse becomes prominent with the ability to remain as a powerful tool for teacher training programmes to provide necessary practice for oncoming or in-service teachers. The metaverse can become a dynamic learning environment providing oncoming teachers with personalized and impactful feedback and further can allow educators to explore the new era of technology and develop learner-centered activities (Yeganeh & Bahrami, 2025; Tsai, 2023) in modern educational environments.

Within this context, the results clearly display the wide range of opportunities that are welcomed by the participants such as creating real-life-like learning and teaching atmosphere, innovative and interactive lessons, and the ability to get fully engaged despite the fact of being in front of a screen. In this respect, education needs to follow the trends and integrate itself into more sophisticated technology to meet the needs of the younger digital youth and make formal educational more appealing to them. Although Prensky (2001) has defined the youth as digital natives, it can be seen that the evolving technology has a significant impact on the definition of generation z who are surrounded by technology and might be even defined as "synthetic natives". Particularly, in a world of social media and diverse identities on the internet, individuals prefer creating avatars and desired personas to represent themselves in the sophisticated virtual world (Ko & Kim, 2024). The excerpts hereby clearly display the increase in motivation as well as the decrease in hesitation since these virtually represented identities enable users to express themselves distinguished from their physical forms, social status, or identity. Hence, users are more comfortable in engaging in interactions with reduced social anxiety and sharing ideas freely which they may find difficult to do so in real life.

Overall, relocating OMLS into the metaverse offers numerous advantages across social and educational domains. Compared to traditional platforms, individuals are able to experience higher level of engagement facilitating the users to communicate, cooperate, and collaborate without geographical limits. In regard to OMLS, the metaverse allows participants to create innovative lesson plans to be integrated into innovative environments and collaborate for the sake of meeting the needs of future students. Furthermore, the shift into the virtual world offers

students to act freely without considering physical barriers, appearances, space and time. In addition, it clearly promotes the creativity of future teachers enhancing digital literacy that is now an essential competence of the 21st century educators and remains crucial to fulfil the pedagogical roles in the modern world (Mgaya, 2024).

REFERENCES

Akdemir, A. B., & Kılıç, A. (2020). Yükseköğretim öğrencilerinin uzaktan eğitim uygulamalarina bakışı. *Journal of National Education/Millî Eğitim Dergisi*, *49*(1), 685-712. https://doi.org/10.37669/milliegitim.783344

Ball, D. L., & Cohen, D. K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In G. Sykes and L. Darling-Hammond (Eds.), Teaching as the learning profession: *Handbook of policy and practice* (pp. 3-32). Jossey Bass.

Barth, J., Schneider, S., & von Känel, R. (2010). Lack of social support in the etiology and the prognosis of coronary heart disease: A systematic review and meta-analysis. *Psychosomatic Medicine*, 72(3), 229–238. https://doi.org/10.1097/PSY.0b013e3181d01611

Bekereci-Sahin, M., & Aslan, R. (2026). Navigating online microteaching: pre-service teachers' experiences and insights. Pedagogies: *An International Journal*, *21*(1), 119–136. https://doi.org/10.1080/1554480X.2025.2535343

Benton-Kupper, J. (2001). The microteaching experience: Student perspectives. *Education*, *121*(4), 830-835. https://openurl.ebsco.com/EPDB%3Agcd%3A13%3A6021901/detailv2?sid=ebsco%3Aplink%3Acrawler-gcd&id=ebsco%3Agcd%3A5016918&crl=c&jrnl=00131172&link_origin=scholar.google.com

Bohndick, C., et al. (2025). Students' personality impacts sense of belonging of students in different ways. *Social Psychology of Education*, *28*(1), 98. https://doi.org/10.1007/s11218-025-10058-0

Campbell, S., et al. (2020). Coding in-depth semistructured interviews: Problems of unitization and intercoder reliability and agreement. *Sociological Methods & Research*, *49*(3), 837–861. https://doi.org/10.1177/0049124118785670

Chasciar, D.R., et al. (2025) The impact of the COVID-19 pandemic on university education in the field of construction: adaptations and challenges in the entrepreneurial training of students. *Front. Educ.*, *10*, 1623392. https://doi:10.3389/feduc.2025.1623392

Cochran-Smith, M., & Villegas, A. M. (2015). Framing teacher preparation research: an overview of the field, part 1: an overview of the field, part 1. *Journal of Teacher Education*, *66*(1), 7-20. https://doi.org/10.1177/0022487114549072

Crandall, J. (1993). Professional development and teacher research. *TESOL Quarterly*, *27*(2), 327–331. https://doi.org/10.2307/3587265

Crandall, J. (1994). Professional development and the research/practice connection. *TESOL Quarterly*, *28*(2), 267–270. https://doi.org/10.2307/3587345

Crandall, J. (1996). Professional development and teacher research. In J. C. Richards (Ed.), *Teacher education for language teachers* (pp. 32–48). Cambridge University Press.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). *Sage Publications*.

Daher, R. (2025) Integrating AI literacy into teacher education: a critical perspective paper. *Discov Artif Intell*, *5*, 217. https://doi.org/10.1007/s44163-025-00475-7

Darling Hammond, L. (1994). *Professional development schools: Schools for developing a profession*. Teachers College Press. https://eric.ed.gov/?id=ED364996

De Almeida, I. G., & Weber, J. P. (2025). Pre-service teachers' experiences of online microteaching in South Africa. *African Journal of Teacher Education and Development*, *4*(1), a90. https://journals.co.za/doi/epdf/10.4102/ajoted.v4i1.90

Derakhshandeh, Z., & Esmaeili, B. (2020). Active-learning in the online environment. *Journal of Educational Multimedia and Hypermedia*, *29*(4), 299-311. https://www.learntechlib.org/p/217506/

Ding, M., et al. (2024). A review of lesson study in mathematics education from 2015 to 2022: Implementation and impact. *ZDM Mathematics Education*, 56, 87–99. https://doi.org/10.1007/s11858-023-01538-8

Fernandez, M. L. (2009). Investigating How and What Prospective Teachers Learn Through Microteaching Lesson Study. *Teaching and Teacher Education*, 351-362. https://doi.org/10.1016/j.tate.2009.09.012

Flores, M. A., et al. (2024). Online learning, perceived difficulty and the role of feedback in COVID-19 times. *Research in Post-Compulsory Education*, *29*(2), 324-344. https://doi.org/10.1080/13596748.2024.2330784

Gichuhi, L. (2025). Teacher trainees' perspectives on the use of technology for teaching and learning in forced displacement contexts. *Journal of Interactive Media in Education*, *2025*(1), 3-3. https://doi.org/10.5334/jime.884

Grossman, P., Hammerness, K., & McDonald, M. (2009). Redefining teaching, re-imagining teacher education. *Teachers and Teaching*, *15*(2), 273–289. https://doi.org/10.1080/13540600902875340

Heffner, K. L., et al. (2011). Social isolation, C-reactive protein, and coronary heart disease mortality among community-dwelling adults. *Social science & medicine*, *72*(9), 1482-1488. https://doi.org/10.1016/j.socscimed.2011.03.016

Hilliker, S. (2020). Virtual exchange as a study abroad alternative to foster language and culture exchange in TESOL teacher education. *Tesl-Ej*, *23*(4), n4. https://eric.ed.gov/?id=EJ1242714

Ko, C., & Kim, S. (2024). Adolescent female users' avatar creation in social virtual worlds: opportunities and challenges. *Behavioral Sciences*, *14*(7), 539. https://doi.org/10.3390/bs14070539

Kosnik, C., et al. (2018). Infusing literacy into teacher education programs: 22 case studies of initial teacher preparation. *Routledge*. https://doi.org/10.4324/9781315107295

Kotelawala, U. (2011). Lesson study in a methods course: connecting teacher education to the field. *The Teacher Educator*, *47*(1), 67–89. https://doi.org/10.1080/08878730.2012.633840

Lin, S., et al. (2022). Metaverse in education: vision, opportunities, and challenges. 2022 *IEEE International Conference on Big Data (Big Data)*, Osaka, Japan, 2857-2866. 10.1109/BigData55660.2022.10021004.

Lewis, C., et al. (2019). How does lesson study work? Toward a theory of lesson study process and impact. In R. Huang, A. Takahashi, & J. P. da Ponte (Eds.), *Theory and practice of lesson study in mathematics: An international perspective* (pp. 13–37). Springer. https://link.springer.com/chapter/10.1007/978-3-030-04031-4_2

McKim, C. (2023). Meaningful member-checking: A structured approach to member-checking. *American Journal of Qualitative Research*, *7*(2), 41-52. https://doi.org/10.66815/ajqr/12973

McMillan, J. H., & Schumacher, S. (2010). *Research in education: evidence-based inquiry, myeducationlab series*. Pearson. https://eric.ed.gov/?id=ED577250

Mgaya, R. (2024). Problems confronting the teaching profession in tanzania and implications towards educational excellence in the digital age. *Journal of Learning for Development*, *11*(3), 563-573. https://eric.ed.gov/?id=EJ1449706

Minea-Pic, A. (2020). *Innovating teachers' professional learning through digital technologies* (No. 237). OECD Publishing. https://www.oecd.org/en/publications/innovating-teachers-professional-learning-through-digital-technologies_3329fae9-en

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Murata, A. (2011). Introduction: Conceptual overview of lesson study. Lesson study research and practice in mathematics education: *Learning Together*, 1-12. https://link.springer.com/chapter/10.1007/978-90-481-9941-9_1

Ning, Y., et al. (2024). Teachers' AI-TPACK: Exploring the Relationship between Knowledge Elements. *Sustainability*, *16*(3), 978. https://doi.org/10.3390/su16030978

Oh, S. Y., & Ahn, Y. (2024, July). Exploring teachers' perception of artificial intelligence: The socio-emotional deficiency as opportunities and challenges in human-AI complementarity in K-12 education. *In International conference on artificial intelligence in education* (pp. 439-447). Springer Nature Switzerland.

Palinkas, L. A., et al. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*, *42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Potter, J., et al. (2025). Making up for lost time: University students' quest to reclaim missed opportunities while adjusting to post-Covid life in higher education. *British Educational Research Journal*. https://doi.org/10.1002/berj.4165

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, *9*(5), 1–6. https://doi.org/10.1108/10748120110424816

Qin, X. (2024). Collaborative inquiry in action: a case study of lesson study for intercultural education. *Asian-Pacific Journal of Second and Foreign Language Education*, *9*(1), 66. https://doi.org/10.1186/s40862-024-00294-w

Renzulli, J. S. (2021). The teacher's role in developing higher level thinking skills in young people. *Revista Espanola De Pedagogia*, *79*(278), 13-32. https://doi.org/10.22550/REP79-1-2021-01

Richards, J. C. (2008). Second language teacher education today. *RELC Journal*, *38*(2), 158–177. https://doi.org/10.1177/0033688208092182

Schleicher, A. (2020). *The Impact of COVID-19 on Education: Insights from" Education at a Glance 2020"*. OECD Publishing. https://eric.ed.gov/?id=ED616315

Sims, R., & Walsh, L. (2009). Learning from teaching: Collaboration and theory in teacher education. *Teaching and Teacher Education*, *25*(5), 731–739. https://doi.org/10.1016/j.tate.2009.01.008

Smit, A., et al. (2021). Moving beyond text-and-talk in qualitative health research: Methodological considerations of using multiple media for data collection. *Qualitative Health Research*, *31*(3), 600-614. https://doi.org/10.1177/1049732320976556

Subasman, I. (2024). Improving The practice of teacher learning reflection through digital technology-based lesson study. *AL-ISHLAH: Jurnal Pendidikan*, *16*(2), 2621-2634. https://doi.org/10.35445/alishlah.v16i2.4905

Sullivan, M. (2021). *What the metaverse will (and won't) be, according to 28 experts*. Fast Company. https://www.fastcompany.com/90691510/what-is-the-metaverse

Susilo, H. (2015). *Pengembangan kualitas pembelajaran melalui lesson study*. LP3 Universitas Negeri Malang.

Takahashi, A., & McDougal, T. (2016). Collaborative lesson research: Maximizing the impact of lesson study. *ZDM Mathematics Education*, *48*(4), 513–526. https://doi.org/10.1007/s11858-015-0752-x

The Holmes Group. (1986). *Tomorrow's schools: Principles for the design of professional development schools*. The Holmes Group. https://www.edweek.org/education/holmes-group-outlines-clinical-schools-network/1990/02#:~:text=%E2%80%9CThat%20can%20be%20very%20different%20from%20being,students%20who%20are%20poor%20or%20members%20of

Tsai, Y. C. (2023). Learner-centered analysis in educational metaverse environments: exploring value exchange systems through natural interaction and text mining. *Journal of Metaverse*, *3*(2), 121-132. https://doi.org/10.57019/jmv.1302136

Ventista, O. M., & Brown, C. (2023). Teachers' professional learning and its impact on students' learning outcomes: Findings from a systematic review. *Social Sciences & Humanities Open*, *8*(1), 100565. https://doi.org/10.1016/j.ssaho.2023.100565

Yeganeh, L. N., et al. (2025). The future of education: A multi-layered metaverse classroom model for immersive and inclusive learning. *Future Internet*, *17*(2), 63. https://doi.org/10.3390/fi17020063

Younas, A., & Inayat, S. (2025). Choosing an analytical approach in case study research. *Creative Nursing*, *31*(1), 90-92. https://doi.org/10.1177/10784535241306773

Zawacki-Richter, O., et al. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators?. *International journal of educational technology in higher education*, *16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0

Zhu, Y. (2022). A systematic review of the application of metaverse in language education. *Journal of Language Teaching*, *53*(3), 620–646. https://doi.org/10.1111/bjet.13191

Hakem Değerlendirmesi
Dış bağımsız
Yazar Katkısı
Fikir/Kavram: TÇ (%70) ve Gİ (%30), Tasarim/Design: TÇ (%60) ve Gİ (%40), Denetleme/Danişmanlik: Gİ (%100), Kaynaklar: TÇ (%90) ve Gİ (%10), Malzemeler: TÇ (%100), Veri Toplama/İşleme: TÇ (%100), Analiz/Yorum: TÇ (%80) ve Gİ (%20), Literatür Taramasi: TÇ (%70) ve Gİ (%30), Yazi Yazan: TÇ (%100), Eleştirel İnceleme: Gİ (%100).
Veri Seti Erişimi
Mevcut çalışma sırasında kullanılan ve/veya analiz edilen veri setleri, makul bir talep üzerine sorumlu yazardan temin edilebilir.
Finansal Destek
Sorumlu yazar, bu çalışmanın herhangi bir finansal destek almadığını beyan etmiştir.
Çıkar Çatışması
Sorumlu yazar herhangi bir çıkar çatışması olmadığını beyan etmiştir.
Etik Beyan
Bu çalışmanın etik ilkelere uygunluğunun incelenmesi için Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Müdürlüğü'ne başvurulmuş olup ilgili müdürlük tarafından 31.10.2023 tarihli E-838991 sayılı resmi yazı ile bu çalışmanın etik ilkelere uygun olduğu belirtilmiştir.
Bilgilendirilmiş Onam
Araştırmaya katılan tüm katılımcılardan online bilgilendirilmiş onam alınmıştır ve katılımcılara çalışmanın amacı, yöntemleri, olası riskler ve hakları detaylı olarak açıklanmıştır.
Bilgilendirme
Bu makalede araştırma ve yayın etiğine uyulmuştur.
Yazışmalar ve materyal talepleri ile ilgili konular için sorumlu yazarla iletişim kurulmalıdır.
Bu makalede üretken yapay zeka destekli teknolojileri yalnızca metnin okunabilirliğini ve dilini iyileştirmek amacıyla kullanılmıştır.
Makalede kullanılan üretken yapay zeka aracı Google Gemini 3.6 Flash.
Bu makale birinci yazarın ikinci yazar danışmanlığında hazırlamış olduğu doktora tezinden üretilmiştir.
Tüm yazarlar, makalenin yayınlanmış versiyonunu okumuş ve kabul etmiştir.

Peer-review
Externally peer-reviewed.
Author Contributions
Concept / Idea: TÇ (70%) and Gİ (30%), Design: TÇ (60%) and Gİ (40%), Supervision / Consultancy: Gİ (100%), Resources: TÇ (90%) and Gİ (10%), Materials: TÇ (100%), Data Collection / Processing: TÇ (100%), Analysis / Interpretation: TÇ (80%) and Gİ (20%), Literature Review: TÇ (70%) and Gİ (30%), Writing: TÇ (100%), Critical Review: Gİ (100%).
Data Availability Statement
The data sets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.
Funding
The author declared that this study has received no financial support.
Conflict of Interest
The corresponding author has no conflict of interest to declare.
Ethical Approval
The ethics committee approval of the thesis from which the article was produced was obtained from Çukurova University Ethics Committee with the decision numbered E-838991 on 31.10.2023
Informed consent
Informed consent was obtained from all participants, and they were provided with detailed information about the purpose of the study, its methods, potential risks, and their rights.
Acknowledgement
Research and publication ethics were followed in this article.
Correspondence and requests for materials should be addressed to Corresponding Author.
This article used generative AI-powered technologies solely to improve the readability and language of the text. The generative AI tool used in the article Google Gemini 3.6 Flash.
This article is based on the first author's doctoral dissertation, completed under the supervision of the second author.
All authors have read and accepted the published version of the manuscript.