ReCALL (2024), 36: 3, 251–269
doi:10.1017/S0958344024000089

RESEARCH ARTICLE

Preparing teachers for the future: Microteaching in the immersive VR environment

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Abstract

The present study aims to explore how pre- and in-service language teachers incorporate the cutting-edge technology of immersive virtual reality (iVR) into their teaching practice. Specifically, the study examined how their different knowledge levels and teaching experiences influenced their integration of technology by analyzing their performance-based tasks in microteaching in an iVR environment. This particular technology was selected for the study because it was expected to bring multiple pedagogical benefits to future foreign language learning classrooms, such as contextualized learning, increased learner motivation and interest, and enhanced interaction and communicative skill training. The study employed in-depth qualitative analysis. Data (lesson plans, screen recordings of microteaching episodes, and reflection papers) were collected from one preservice teacher training course and one in-service teacher training course at a Korean university. The study found a large gap between pre- and in-service teacher performance and identified the sources of the differences based on qualitative data analysis. The results showed that not only teachers' technological knowledge but also their pedagogical knowledge of the use of technology and confidence in teaching affected technology integration. As technology integration has become more important in language education, the current study provided insight into how to better prepare teachers for future learners.

Keywords: immersive VR; teacher education; microteaching; technology integration

1. Introduction

Over decades, language teachers' competencies with technology have been addressed as an important topic in education (Kessler, 2021; Lan, 2020). As technologies have been rapidly developing in recent years, technology-enhanced language learning (TELL) preparation has become even more important. Among the emerging technologies, immersive virtual reality (iVR) seems to be more well accepted and applied in language education (Wu, Miller, Huang & Wang, 2023). iVR is a technology that creates an artificial, virtual environment, replacing the user's real-world surroundings (Lee, Yang & Wu, 2023; Wu, Zhang & Lee, 2024). The key features of iVR include full immersion, perception of physical presence, utilization of avatars, and interaction (Lee *et al.*, 2023; Mystakidis, 2022; Taguchi, 2021; Wu *et al.*, 2024).

In language learning, context plays a critical role (Lee & Park, 2020). However, in many countries that use English as a foreign language (EFL), such as Korea and China, language learning

Cite this article: Lee, S-M. & Wu, J.G. (2024). Preparing teachers for the future: Microteaching in the immersive VR environment. *ReCALL* 36(3): 251–269. https://doi.org/10.1017/S0958344024000089

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https://doi.org/10.1017/S0958344024000089 Published online by Cambridge University Press

is mostly limited to decontextualized classroom practice (Chen, Wang, Zou, Lin & Xie, 2019). By relying on students' imaginative skills in the communicative contexts of linguistic role-play, language learning often remains demotivating, unmeaningful, and difficult for EFL learners (Lee & Park, 2020; Yang, 2006). In contrast, iVR environments aligning with constructivist learning theory can simulate authentic scenarios and afford learners unique chances to "immerse themselves in the created contexts by using their avatars or by simply wearing 3D glasses, and then explore the contexts" (Lan, 2020: 2).

Prior studies have identified numerous educational benefits of VR and iVR in language education, such as the development of vocabulary (Alfadil, 2020), listening skills (Tai, 2022), willingness to communicate (Ebadi & Ebadijalal, 2022), and cultural competencies (Yeh, Tseng & Heng, 2022). Compared to traditional classrooms, situated, contextualized iVR worlds are more likely to empower EFL learners to produce effective language learning in which knowledge is constructed and internalized, motivation and engagement are increased and sustained, and interactions are encouraged and customized (Taguchi, 2021). In addition, the diverse representations in iVR empower users with different resources to leverage this new technology and language teachers and learners are able to select the appropriate VR tools based on their budget and needs, further increasing the popularity of iVR in language education (Chen, 2022).

Despite its growing popularity, iVR remains a novel technology in teacher training, and the teaching content has been built around traditional technologies in Korea (Lee & Ahn, 2021; Park & Son, 2022). Moreover, as the literature has noted, "CALL practice continues to be superficial and not meaningfully integrated into instructional practice" (Kessler, 2021: ii). In Korea, despite the increasing availability of technology in the classroom, language teachers do not receive adequate and sufficient TELL preparation (Kim, Xie & Cheng, 2017; Lee & Ahn, 2021). Against this backdrop, the current study aims to develop Korean pre- and in-service teachers' knowledge, attitudes, and skills to successfully integrate technologies in education, namely, their technological competencies (TCs; Foulger, Graziano, Schmidt-Crawford & Slykhuis, 2017), by utilizing iVR and to understand how pre- and in-service teachers' different levels of TCs affected their microteaching performance in iVR.

2. Literature review

2.1 TELL preparation in language teacher education

The quality of teaching and learning often depends on the teacher's knowledge, experience, and skills. As many technologies are emerging and advancing quickly, it is challenging for language teachers to keep up with technological change and understand how to effectively integrate emerging technologies into their classrooms (Wu *et al*., 2024). Thus, teachers' TCs are required more than ever. Teachers' TCs can be defined as knowledge, attitudes, and skills that enable a teacher to successfully use a wide array of technologies in and beyond the classroom (Foulger *et al*., 2017). According to Tondeur, Howard and Yang (2021), teachers' TCs are highly influenced by their previous experiences with technology, efficacy, knowledge, and pedagogical beliefs and attitudes towards technologies.

One of the most powerful and well-known ways to integrate technology into education is the technological pedagogical content knowledge (TPACK) model (Mishra & Koehler, 2006). TPACK has been also widely used to educate pre- and in-service teachers, measure their TCs, and evaluate technology training programs for teachers (Eutsler, 2022). According to TPACK, to acquire appropriate TCs, teachers need to develop knowledge in multiple domains: technology, content, pedagogy (core domains), and technological content, pedagogical content, and technological pedagogical knowledge, derived from the interaction and reciprocal relationships among the core domains (Koehler, Shin & Mishra, 2011; Wang, Schmidt-Crawford & Jin, 2018). The core concept of TPACK is that teachers should acquire technological pedagogical content knowledge to meaningfully and authentically apply technology in their classrooms.

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Another widely adopted framework as a pragmatic guide for building teachers' TCs is the substitute adaptation modification replacement (SAMR) model. The SAMR model proposes four stages in using technology in education (Puentedura, 2013). At the substitution and augmentation stages, technology is used merely for enhancement and acts as a direct tool substitute. At the modification and redefinition stages, technology is used for transformation and requires significant task redesign. At the redefinition stage, technology enables the creation of new tasks that were not previously conceivable and supports greater levels of curriculum innovation. While TPACK describes what knowledge is required for effective technology integration in education, SAMR shows the levels of teachers' TCs (Falloon, 2020).

Over the last few decades, a number of studies have emphasized the importance of TELL teacher preparation (Hubbard, 2021; Kessler, 2021; Lee & Ahn, 2021); however, at the same time, they have also pointed to the insufficiency, inadequacy, and inappropriateness of TELL preparation and, most significantly, the lack of TELL in teacher education (Kessler, 2021). With the lack of TELL preparation an issue worldwide, educators such as Hubbard (2021) and Park and Son (2022) have reminded us that many pre- and in-service language teachers tend not to be well prepared for 21st century teaching, and they often experience difficulties utilizing technology or are not able to use technology at all.

More specifically, Hauck and Kurek (2017) outlined the challenges of teacher education and the necessity of improving teachers' TCs. First, preservice teachers may not have the chance to fully update their beliefs and practices due to the lack of first-hand experience using technology in education. Second, most pre- and in-service language teachers have not received adequate training regarding the integration of technology. As a result, they may not be able to develop their TCs as situated knowledge practices. Therefore, the involvement of future teachers in practical, hands-on experience with new technology is beneficial for understanding the affordances and constraints of technologies. Furthermore, preservice teachers should be prepared for "diversity, unpredictability, and change" (Hauck & Kurek, 2017: 283) so that they can become more confident and make better judgments about when, where, and how to use technology in their future language teaching.

2.2 Microteaching and iVR

In language teacher education programs, microteaching is a common pedagogical technique to support teachers in understanding pedagogical theory, sharpening teaching skills and strategies, putting their TPACK knowledge into practice, and improving core teaching competencies (Theelen, van den Beemt & den Brok, 2019). Microteaching aims to help student teachers plan, teach, observe, and reflect on their teaching through teaching a short lesson with a small number of students (Fernández, 2010). It also bridges the gap between theory and practice and allows teachers to reflect on and refine their practice (Thompson & Woodman, 2019).

Studies have reported that using VR and iVR technology can further benefit microteaching. It offers a safe, low-anxiety environment for experimenting with teaching practices (Chen, 2022), increases the enjoyability of microteaching (Bautista & Boone, 2015), enhances preservice teachers' technological competencies and confidence, and enables situated learning for trainee teachers' skill acquisition, including TCs (Kozlova & Priven, 2015; Wu & Lee, in press). In particular, prior literature suggests that the iVR environment can increase trainee teachers' interest, motivation, and engagement in knowledge acquisition (Lin, Yu, Sun & Jong, 2021), enhance their sense of immersion and presence, and empathy (Stavroulia, Baka, Lanitis & Magnenat-Thalmann, 2018), and improve their learning performance (Lee & Hwang, 2022). Billingsley, Smith, Smith and Meritt (2019) suggested in their systematic review that iVR provided enriched learning opportunities and better preparation for future teachers, but research in this area is significantly lacking.

In addition, there is still a lack and inadequacy of teacher education regarding TELL (Kessler, 2021; Park & Son, 2022). Similarly, in Korea, most preservice teachers start their careers without

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adequate training to bridge knowledge and practice (Cho & Ma, 2019; Lee & Ahn, 2021) and both pre- and in-service teachers do not have enough opportunities to explore and integrate technology into practice (Choi, 2020). In particular, considering the potential benefits of using iVR for language education, training to prepare teachers to better incorporate this new technology into their own teaching requires special attention (Lan, 2020). In this study, both pre- and in-service teachers engaged in practice based on the TPACK and SMAR models in their teacher training courses. The aim was to observe how these two distinct groups of educators showcased their TCs by integrating iVR into their microteaching. The current paper addresses the following questions:

1. How did pre- and in-service teachers utilize the iVR environment in their microteaching?
2. To what extent did each group demonstrate their TCs differently in microteaching? What factors affected the differences between the groups?

3. Methods

3.1 Participants and context

The present study was conducted in two teacher education classes, one undergraduate ($N = 7$) and one graduate ($N = 5$), at a university in Korea. Both classes aimed to increase teachers' TCs, along with pedagogical competencies. It is worth noting that while the undergraduate students were preservice teachers with no prior teaching experience (aged between 20 and 22), the graduate students were in-service teachers with varied teaching experience from 5 to 15 years (aged between 28 and 35). However, none of the undergraduate and graduate students had experienced iVR prior to the class. Since Immerse (https://www.immerse.online/), which was utilized in microteaching, has a limited class size of 10 users, this exploratory study invited only a small number of student participants.

Developed particularly for language learning, Immerse provides various scenarios in which students can learn and use the target language for a specific location and situation (Figure 1). Users can create their own avatars and communicate via synchronous voice and text. The platform provides diverse instructional functions, such as video presentation, rally (gathering students), team (grouping students), focus (freezing students to focus on the instructor), and placeable objects (Figure 2). According to Kaplan-Rakowski and Gruber (2019), high-immersion VR includes a head-mounted display and creates a high sense of immersion, whereas low-immersion VR is based on a two-dimensional monitor (e.g. PC); this difference results in different user experiences in terms of interaction, immersion, and sense of control. Immerse, as high-immersion VR with visual, auditory, and kinesthetic modes, allows human-to-human interaction and interaction and manipulation with objects (Sadler & Thrasher, 2023).

For microteaching, first, both participant groups explored Immerse to become familiar with iVR technology using the head-mounted device with hand controllers (Oculus). Then, they selected places and developed lesson plans (45-minute period for each participant) for middle school EFL students. In the following weeks, the participants continued to develop and revise the lesson plans and finally performed microteaching in iVR. During microteaching, one participant played the teacher role, and the other participants played the role of the target students. The instructions for microteaching included that participants should (1) microteach based on their lesson plans and (2) familiarize themselves with the features of Immerse and incorporate them into microteaching for effective language learning. Prior to microteaching, participants had several opportunities to explore and practice microteaching in Immerse. Each microteaching session lasted 30 minutes. The procedure is summarized in Table 1.

From the perspective of TPACK, student teachers can benefit more regarding their technological pedagogical knowledge from collaborative teaching (Koehler *et al.*, 2011). Due to their lack of experience and knowledge, the undergraduate students developed their lesson plans

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Table 1. Procedure of microteaching

Week	Topic
1	Getting familiar with iVR and selecting a topic for a lesson plan
2	Developing a lesson plan
3	Revising the lesson plan based on the instructor's feedback
4	Applying the lesson plan in iVR
5	Conducting microteaching in iVR
6	Sharing feedback and reflections

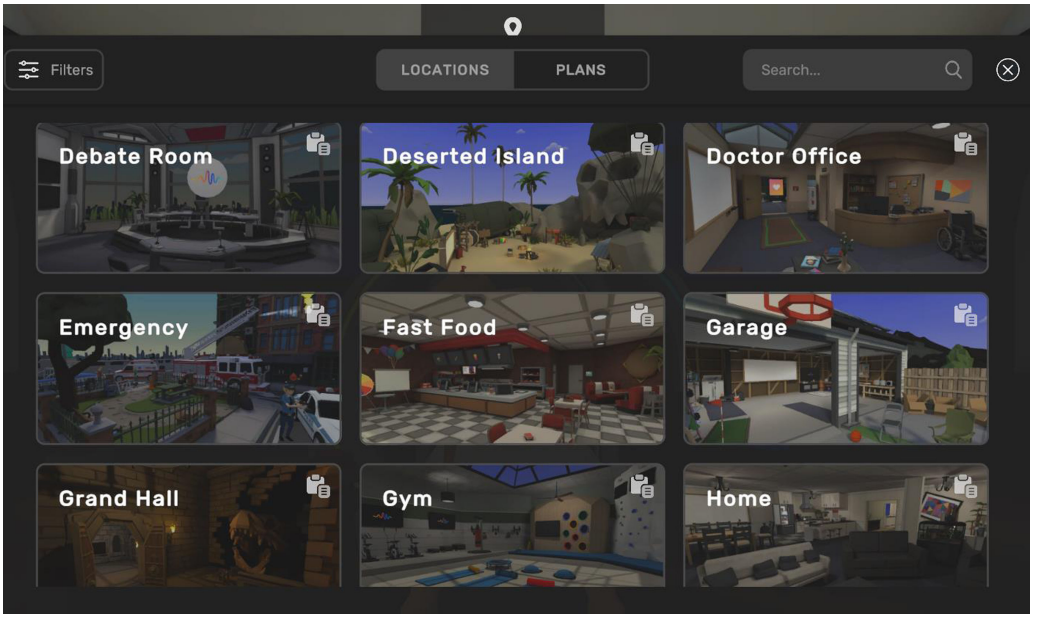


Figure 1. Place selections

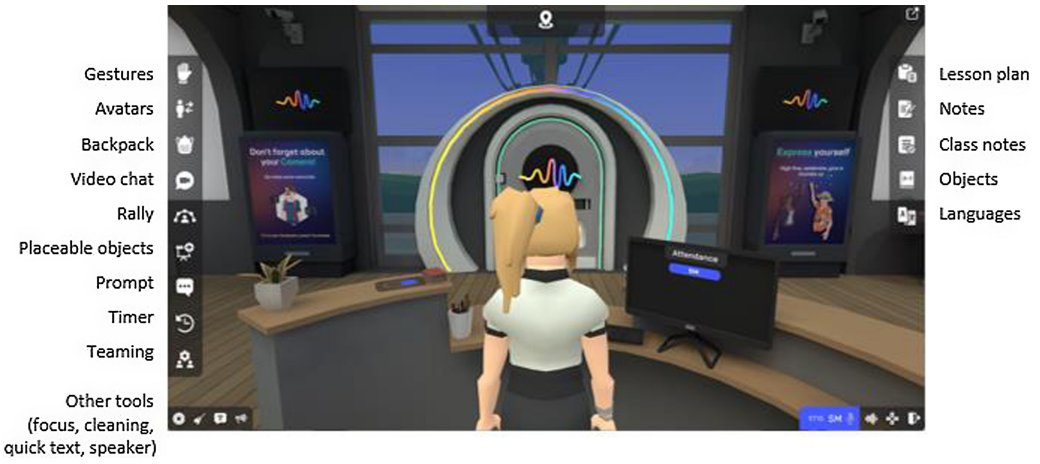


Figure 2. Instructional functions of Immerse

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collaboratively in teams. Each lesson plan included more than three periods so that each student had their own moment for microteaching within the lesson plan. Upon the completion of microteaching, the students wrote two-page reflection papers in which they discussed the advantages and disadvantages of using iVR for language learning and microteaching, their focuses, strengths, and weaknesses of their lesson plans and microteaching, and evaluations of others' microteaching.

3.2 Data collection and analysis

The present study was an exploratory study based on the qualitative research method. The main data set included the video recordings of microteaching (348 minutes in total), students' lesson plans, and their reflection papers. Thematic analysis was conducted to analyze the lesson plans and reflections, and the qualitative coding protocol (Braun & Clarke, 2006) was applied. Two researchers viewed the data multiple times until themes emerged, and then they defined and labeled the themes, created categories to organize the themes, and analyzed the data accordingly (Table 2). As multiple views (e.g. learners', instructors') are important in classroom-based studies (Hartwick, 2018), in addition to recorded observation of microteaching, the students' reflection papers were also collected to further include the students' views. After open coding, the emerging themes from the reflection papers were identified and grouped into two categories: the advantages and the disadvantages of using iVR and the increased TCs of the participants. TCs were further subcategorized through selective coding into technological pedagogical, technological pedagogical content, and technological content knowledge based on the sub-areas of technological knowledge in the TPACK model (Mishra & Koehler, 2006).

Regarding the analysis of video recordings, the first researcher coded the data with Atlas.ti, which allowed the researchers to tag codes to text and media data, see the relationships among the codes, and visualize the coding results of the analysis (Figure 3). After the initial coding, the second researcher reviewed the coding results, and through multiple discussions, mutual agreement on coding and categorization was achieved (see Table 2). The current paper labeled the graduate students as G and the undergraduate students as U, and each participant was coded as a number according to the alphabetical order of their names (G1, G2, G3 . . . U1, U2 . . .). In addition, as the participants played a teacher's or target students' roles in microteaching, they were also marked as T (teacher) and TS (target students) in the analysis of the microteaching recordings. The analysis results of the lesson plans, microteaching, and reflections were triangulated. As the lesson plans showed the same themes as microteaching, they were redundant information, and the current paper focused on the analysis results of microteaching and reflection papers.

4. Findings

4.1 Students' use of iVR in microteaching

Based on the coding of the recordings of the participants' microteaching, 12 categories emerged in three themes (Table 2): language input, language practice, and the use of iVR technology. For microteaching, both groups, based on the nature of the iVR environment, made the pedagogical decision to focus their lessons on the enhancement of oral language skills. The participants employed a variety of activities, both in language input and practice. As shown in Table 2, speaking practice and the teacher's explanations appeared most frequently.

In terms of the use of iVR technology, the participants employed various activities and strategies. The first common example was utilizing the **objects** embedded in the environment. The participants often used the objects found in the environment to teach vocabulary, such as animal names in the zoo and food names in the restaurant. They also utilized objects to teach grammar,

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Table 2. Analysis and examples of students' microteaching

Theme	Category	Description	Coding examples	U	G	Total
Language input	Teacher's explanations	T explaining about the language	Explaining about vocabulary, grammar, and expressions with or without using materials	12	3	15
	Multimedia-based input	T providing multimedia-based input	Using slides, images, and movies	4	10	14
	Text-based input	T providing text-based input	Using text-based slides	2	0	2
Language practice	Speaking	T engaging TS in speaking activities	Conversing with partners using target expressions, repeating after the teacher	15	10	25
	Vocabulary	T engaging TS in vocabulary practice activities	Learning new words, using objects or flashcards to learn the words	7	2	9
	Role-play	T engaging TS in the role-play	Taking a specific role in the situation	0	7	7
	Writing	T engaging TS in writing activities	Writing recipes and reviews on the notepad in the backpack	1	3	4
	Grammar	T engaging TS in grammar practice	Fill-in-the-blanks, talking about grammar	3	0	3
Utilization of iVR technology	Objects	T using/showing objects	Finding items, touching and using objects	8	25	33
	Actions	TS moving and interacting with the environment or objects to perform a task	Moving around in the place, making food/magic potions, making sentences with flashcards, taking a picture	6	19	25
	Instructional functions	T using instructional functions of Immerse	Using the teaming, focus, and rally functions	10	5	15
	Exploration	T having TS explore the environment to get familiar with it	Exploring the environment	3	3	6

Note. U = undergraduate students; G = graduate students; T = teacher; TS = target students.

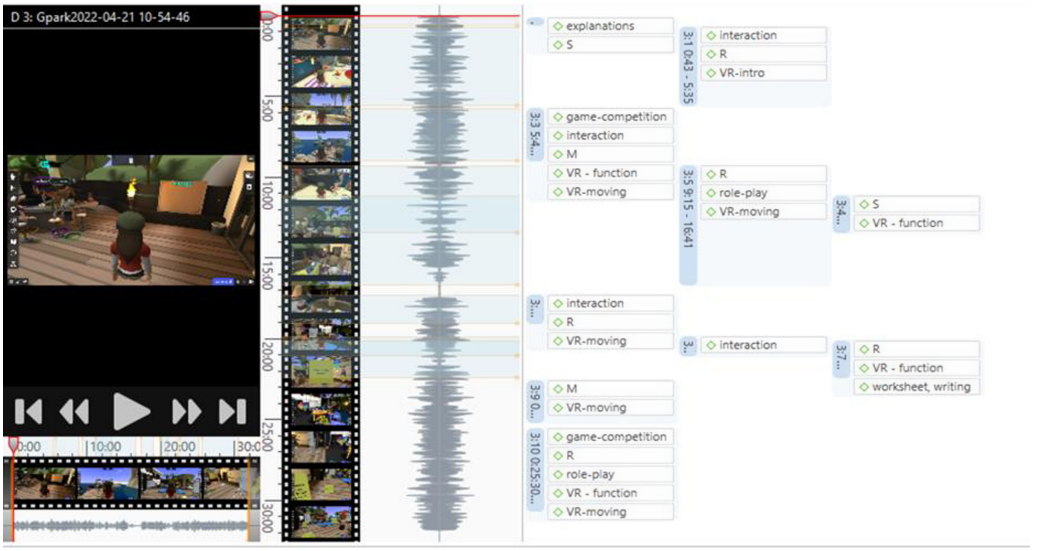


Figure 3. An example of the analysis of microteaching

such as using animals of different sizes to teach comparative adjectives (e.g. The elephant is bigger than the shark). The second common example was **actions** using objects. For example, in the resort, students spoke sentences while tossing a ball to the next person in line. One of the most popular objects was a backpack given to each student, which contained a camera, a notepad, and a pen to use within the environment for taking a photo or writing a review (Figure 4). As the third common example, the participants utilized various **instructional functions** embedded in Immerse. The most commonly used function was material embedding. The participants created a board or TV monitor and embedded materials, such as presentation slides, images, animations, and movies, to show during microteaching (Figure 5). They also used prompts to give instructions, kept a scoreboard and ran a timer for a game, and used flashcards to practice target expressions. In addition, the participants provided time for exploration, during which they gave students some time to look around and become familiar with the environment.

As an example, Table 3 demonstrates the basic structure of G4's (an in-service teacher with three years of teaching experience) microteaching. From Scenes 1 to 3, the teacher (G4) prepared the learners with basic linguistic knowledge and skills by locating new words, viewing an animation, and making sentences. With such relevant linguistic input, the learners in this lesson were then motivated to role-play ordering and eating meals (Scenes 4 to 7). This was an authentic learning activity in that it simulated real-world actions ranging from ordering, preparing, and tasting, to evaluating a meal. In particular, this sample included a photo-taking and food-review activity (Scene 7), which added more authenticity to the lesson since these food shots and writing food reviews are common practices among the younger generations. The students were able to experience multisensory learning as well; they showed different gestures, performed different actions, and moved around the restaurant based on their willingness. To conclude microteaching, students shared their pictures and reviews, which further consolidated their learning (Scenes 8 to 9).

4.2 Differences in microteaching between the groups

In the present study, a few differences were noted between the groups during microteaching. The most distinctive difference concerned their pedagogical approach. While the graduate students

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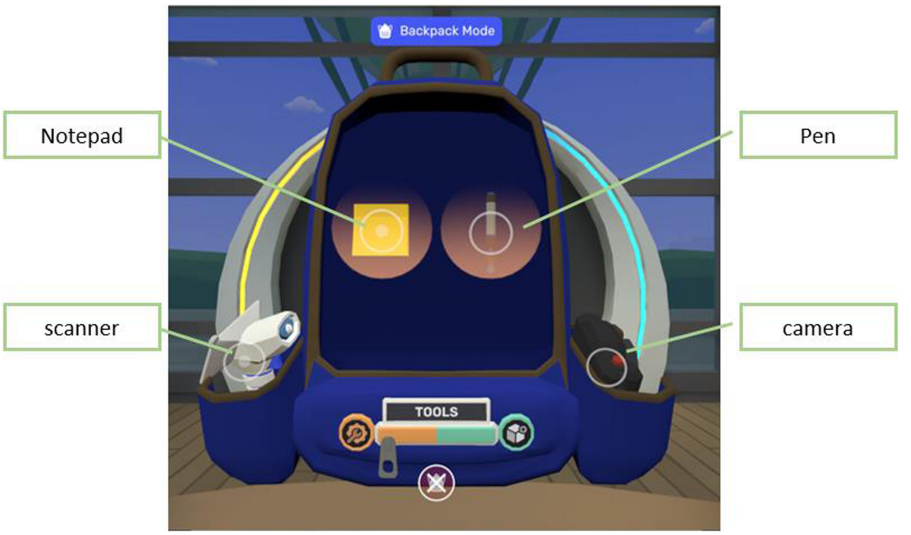


Figure 4. Backpack items



Figure 5. Use of embedded materials

employed student-centered activities, the undergraduate students more frequently used a teacher-centered approach. For instance, when teaching vocabulary, the in-service graduate students provided scaffolding for vocabulary and engaged the target students in a vocabulary game to find words in the environment in teams. However, most of the undergraduate students verbally explained the target vocabulary using PowerPoint slides. Additionally, in terms of interaction, while the graduate students allowed student–student interaction more frequently, the undergraduate students were engaged more in teacher-initiated interactions or teacher–student interactions, such as the process from teacher initiation to student response to teacher evaluation.

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Table 3. The basic structure of G4's microteaching lesson in iVR

 [Scene 1] Vocabulary game Finding items around them and taking turns between the groups to say the word; the group that said more words won; using the scoreboard.	 [Scene 2] Viewing an animation on the TV monitor Watching the animation that T created to teach the target expressions.	 [Scene 3] Making sentences using flashcards
 [Scene 4] Role-play: Ordering food and taking orders	 [Scene 5] Role-play: Making hamburgers	 [Scene 6] Role-play: Serving and tasting the food
 [Scene 7] Role-play Taking a picture of the food and writing a review.	 [Scene 8] Placing the pictures and reviews on the board	 [Scene 9] Sharing pictures and reviews

In contrast, the graduate students assigned different roles to the target students according to the scene, engaged them in role-play, and increased interactions among students.

In addition, the graduate students fully utilized the space and often moved within the space. For instance, G1 started her lesson near the ocean (finding vocabulary and learning target expressions) and then moved to the beach (playing a game using the objects), to inside the resort (spinning a wheel and making up avatars), and to the bar (ordering and making drinks). In contrast, the place where the undergraduate students usually spent much class time was in front of the board or TV monitor as they spent a considerable amount of time explaining the language and showing the learning materials. They also had the target students be seated and pay attention to the teacher while they were explaining, which never occurred with the graduate students. Consequently, teacher-centered activities occupied 79.1% of undergraduate students' microteaching and 21.0% of graduate students' microteaching. On the other hand, student-centered activities accounted for 20.8% of undergraduate students' microteaching and 78.9% of graduate students' microteaching.

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Table 4. Example of G4

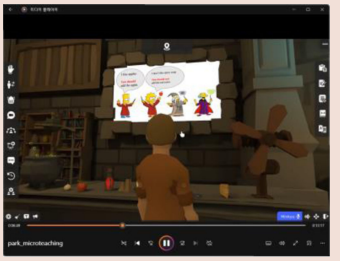
 [Scene 1] T: Let's make two groups. With your group members, find as many words as possible that you can see in the restaurant. (*T placed a scoreboard*). TS1: I am seeing the scoreboard. Can I go there? T: Yes. Let's wait for other students.	 [Scene 2] T: Everybody's here. You guys look excited. Find words around you. TS1 and TS2 are in Group 1. You have two minutes. I am going to begin the timer. You can work in groups or explore by yourself. It doesn't matter. Is this clear? TSs: Yes. T: Okay, let's get started.	 [Scene 3] TS1: Can we walk around? T: Sure, walk around and find words. TS2: How can I remember all those words I found? TS1: Oh, my god. You're right. T: Check the backpack. Write the words on the notepad. TS1: Oh, thanks! Hey, guys, how many words did you find?
 [Scene 4] (TSs were moving around to find words and speaking to each other) TS2: You're drinking a lot of water today. TS3: Come over here.	 [Scene 5] T: Group 1, what did you find? TS1: We found the words apple, mocha, and cup. TS2: We also found cake. T: Good. So you found two c-words. (*T scored 4 on the scoreboard*.)	 [Scene 6] T: How about Group 2, what did you find? TS3: We found chair, table. TS4: And cola and pie. *(TSs continued to say words.)*

Note. T = teacher (G4); TS = target students (played by other students).

To further exemplify the differences, some representative teaching moments from undergraduate and graduate students are presented below. In Table 4, the teacher, played by a graduate student (G4), adopted the role of facilitator in the iVR environment. In the first two screenshots (Scenes 1 and 2), the teacher assigned students to participate in a competition (represented by a scoreboard) that required learners to explore the virtual space: a restaurant. G4 initiated small talk (e.g. "You guys look excited."), issued detailed instructions (e.g. "Let's make two groups."), and elicited feedback from the learners (e.g. "Is this clear?"), which made the class more interactive and student centered. In the following two scenes (Scenes 3 and 4), the teacher observed the students' learning performance and only provided feedback (e.g. "Check the backpack.") when necessary. Most of the learning time was devoted to students' collaborative work. In Scenes 5 and 6, G4 rallied the students and monitored their learning progress. In this example, the teacher played the basic role of facilitator and allowed learners to be actively involved in learning by interacting with peers, the teacher, and the environment.

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Table 5. Example of U2

		
[Scene 1] T: Please have a seat, everybody. *(The students were seated on the bench.)* And watch the screen. Let's learn today's target expressions.	[Scene 2] T: In the previous class, you learned the imperative. Today, we're going to learn about "should" and "should not." When you have to do something, you say should. Here Simpson says, "I like apples, so you should add the apple."	[Scene 3] T: Okay, over here. Let's make sentences. . . . You should . . . after this you can add any verb, like add, pour, mix. I am going to use "add." You should add . . . what? Cheese. You can put any noun listed here after the verb.
		
[Scene 4] T: Next, you're going to make your own sentences and give a presentation. Here is a presentation sample. TS3, please read aloud the sentences on the screen. TS1: We added bananas . . . *(The students were still sitting.)*	[Scene 5] T: Now you're going to make soup in groups. TS2, TS3, TS4, you're in one group. The rest are in the other group. Now stand up! *(The students stood up.)* Pour ingredients into the pot and make soup.	[Scene 6] *(The students were making soup in groups and murmuring.)*

Note. T = teacher (U2); TS = target students.

In contrast, Table 5 vividly shows how the undergraduate students taught differently in iVR. Although this group selected an appealing scene of making potions in a wizard's classroom, the teaching arrangements did not deviate much from the teaching practices in a traditional classroom. First, in the six screenshots in Table 5, most of the lesson time was occupied with teacher talk, which was largely restrained in the graduate student's example in Table 4. Second, from the beginning of Scene 1, the teacher (U2) decided to mimic the traditional approach to learning by asking students to take a seat and watch the screen. Then the teacher started teaching by talking about learning objectives and asking students to look at a picture on a PowerPoint slide, which was similar to the typical approach in the traditional classroom. Such teacher-led learning continued in Scenes 3 and 4. In Scene 5, the students were required to participate in a group activity where they were required to produce a pot of potion. The teacher, again, controlled the process by sending meticulous instructions (e.g. "Now stand up!"). In a similar vein, the teacher made extensive use of the functions such as the whiteboard and the rally function to get learners' attention.

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The reflection papers, which helped to identify the reasons underlying the participants' microteaching, also exhibited the differences between the groups. Most importantly, the undergraduate students expressed regrets and concerns about teaching and the teacher's role, such as in the following example:

> . . . we tried to decrease teacher lectures and maximize student activities. However, if such phenomena continue, teachers will just be left with only the role of an activity planner, not a lecturer. (U3)

In this excerpt, U3 considered a lecturer to be an important part of the role of a teacher and undermined the value of a teacher as a planner. Similarly, other students commented about their teacher-centered approach that "I was worried I was not teaching enough" (U1) and "because silence during the activity felt awkward, I tried to avoid it and ended up explaining and teaching too much" (U2). On the other hand, the graduate students showed a pre-existing awareness of the advantages of iVR. G3 pointed out that "there was no space restriction in VR"; thus, there was "no need for static teaching methods, unlike in the traditional classroom where students always sit down and fill in the worksheet."

In addition, both groups mentioned anxiety, although from different perspectives. The graduate students wrote that iVR could benefit students' L2 learning, particularly speaking, because using avatars could reduce learners' performance anxiety around speaking. G1 and G5 mentioned that saving face was very important in Korean classrooms, and this often hindered students' speaking in class, but speaking in iVR could mitigate the situation. On the other hand, the undergraduate students talked about their own reduced anxiety during microteaching. They reported that, while they often felt uncomfortable microteaching in front of their peers and with the instructor in the classroom, they felt less anxious and more comfortable during microteaching in iVR.

On the other hand, the reflection papers indicated that both groups were aware of the pedagogical benefits of using iVR in English education. They mentioned "interest," "fun," and "immersion" most frequently in the reflection papers, and they chose places that could "maximize the fun and authenticity effect." "Context," "situation," and "authenticity" also appeared frequently. The participants mentioned that "the iVR environment could realize the situational/functional syllabus in the classroom" and "was the most effective learning environment to practice oral language skills by placing target students in a specific situation"; thus, they "expected that target students would actively communicate" in iVR. They also pointed to the disadvantages of using iVR, as shown in Table 6.

Overall, despite a few initial difficulties (e.g. becoming familiar with the device and the specific functions of Immerse), both groups regarded microteaching in iVR as "a great learning opportunity to think about teaching strategies and classroom practice" and "future classrooms that we are going to teach in." They also mentioned that microteaching in the iVR environment provided a valuable learning experience through which they were able to "apply what [they] learned to the new environment" and to realize what they could apply and what they could not do easily in the classroom. Both groups discussed a number of ideas to effectively integrate technology connecting to pedagogy and content knowledge in the reflection papers. Whereas the undergraduate students showed a lack of technological pedagogical knowledge in microteaching, the reflection papers showed their awareness of TCs (e.g. discussing how to effectively integrate pedagogy and technology) – 37 times for the undergraduates and 36 times for the graduates in total. In sum, both groups said that microteaching in iVR enabled an opportunity to reflect on their pedagogical and technological skills and connect the skills. They believed that their teaching competencies and technological integration strategies were enhanced through microteaching and that they were "better prepared for the future English classroom."

https://doi.org/10.1017/S0958344024000089 Published online by Cambridge University Press

Table 6. Summary of the reflection paper analysis

Category	Subcategory	U	G	Examples
Using iVR	Advantages	25	28	Interesting, fun, and immersive; motivates learners to have fun in learning English; provides a safe environment; allows contextualized learning; makes the class more interesting than traditional classrooms
	Disadvantages	12	19	Motion sickness, cost, technical difficulties; limited classroom situations, teachers' lack of technological skills
Technological competencies	Technological pedagogical knowledge	15	16	Interacting via avatars hinders providing feedback; iVR can enhance active and interactive learning; teachers should be aware of each function and utilize it according to its purpose
	Technological pedagogical content knowledge	9	8	. . . the use of iVR for role-play provides the context to acquire communicative skills and reduce language anxiety; for successful implementation of iVR, teachers should understand student needs, the curriculum, and effective language teaching methods
	Technological content knowledge	8	7	. . . should have let learners categorize and attach the vocabulary card on the board rather than explaining the word
	Attitudes (confidence, motivation)	5	5	I became more confident about using technology; using technology will be essential in the future classroom

Note. U = undergraduate students; G = graduate students.

5. Discussion

In the current study, the undergraduate (preservice teachers) and graduate (in-service teachers) students designed English lesson plans for an iVR environment and conducted microteaching in Immerse to enhance their TCs. Although all the participants were first-time users of iVR technology, they were able to use the technology for various purposes of teaching without much difficulty. They effectively used movable objects (e.g. balls, trays, food ingredients), requested or allowed students to move and act (e.g. taking photos, making hamburgers), and employed instructional functions (e.g. rally, scoreboards, teaming). Overall, as shown in prior studies (Billingsley *et al*., 2019; Stavroulia *et al*., 2018), microteaching in iVR provided a valuable learning opportunity to increase trainee teachers' technological pedagogical knowledge and reflect their TCs in the present study.

As an event or utterance is situated in context and affects student understanding (Fox & Artemeva, 2022), particularly in language learning, context plays a critical role and learning should be immersed in real-life context (Kozlova & Priven, 2015). Using iVR technology can make situated, social learning possible and bring fundamental change to their learning because students learn the language as a social practice by discovering, acting, experiencing, and interacting within the context (Fox & Artemeva, 2022). For instance, unlike imagined role-plays in traditional classrooms, the iVR environment instantly situates and immerses learners in the intended context. In this environment, role-plays are more vivid, lived experiences, compared to the traditional, imagination-based role-plays. This technology can dramatically alter language learning (Kessler, 2021) and bring a totally new learning experience to future students.

From a teacher's perspective, using iVR requires a high level of both technological and pedagogical knowledge. In terms of SAMR, redesign, the highest stage, is necessary because with this technology, teachers need to reshape the curriculum and lesson plans, renovate classroom practices, and accommodate new practices that were previously inconceivable to maximize student learning (Falloon, 2020). The current study showed that most of the in-service teacher participants were able to redesign the lesson plans to effectively utilize the iVR environment. They provided exploration time for students to become familiar with the environment, included

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motivating simulated activities with interactive objects, and utilized various instructional functions. The simulated role-plays, taking pictures to share with peers, moving objects, and acting following the teacher's instructions are good examples of redesign. This indicates that the participants were able to demonstrate the highest level of SAMR.

However, not all the participants were able to demonstrate a high level of TCs. The difference between the undergraduate and graduate students indicated the undergraduate students lacked technological pedagogical knowledge. Although both groups quickly adapted to the iVR technology, the outcomes of microteaching were distinctly different. With the innovative technology at hand, the undergraduate students still greatly focused on the teachers' explanations and less frequently engaged students in interaction or student-centered activities. For instance, the undergraduate students often explained vocabulary and grammar using PDFs or PowerPoint files with the target students seated. In these instances, technology acted as a direct tool substitute to support lecture-based instruction without functional change or significant task redesign (Puentedura, 2013). In contrast, such instances of substitution appeared far less frequently with the graduate students, and the graduate students employed more interactive and active learning strategies.

While the undergraduate students spent too much time in front of the board explaining the core principles of language due to a lack of confidence, the graduate students effectively utilized the iVR environment where there was "no space restriction" and "the avatar-mediated-world reduced learners' anxiety." This result implied that technological pedagogical knowledge was critical to successful technology integration. To meaningfully integrate technology into the classroom, teachers need to know both how to use technology in teaching and how to teach a specific subject in addition to core knowledge (i.e. content, technology, pedagogy) (Tondeur *et al.*, 2021). The undergraduate students in the present study did not particularly lack technology skills, but as inexperienced novice student teachers, it was challenging for them to transfer the pedagogical knowledge to practice. This finding was also in line with Cheng (2017), who found that teaching experience played a major role in influencing teachers' perceived TPACK.

The undergraduate students' lack of confidence also negatively influenced their microteaching. Teachers' confidence in technology skills and pedagogical use is positively correlated with the successful use of technology in the classroom (Dogan, Dogan & Celik, 2021; Starkey, 2020), and this is particularly true for novice teachers; when teachers do not have enough confidence or self-efficacy in their teaching and classroom use of technology, they are less likely to successfully incorporate technology into the classroom. The undergraduate students in the present study exhibited a lack of confidence about their teaching (e.g. "we were worried if we were teaching enough," "silence during the activity felt awkward"). Compared to microteaching in the traditional classroom, although the undergraduate students felt more comfortable during microteaching in iVR, they did not feel confident about their teaching. Therefore, they tried to supplement with more teacher-centered instruction, and as a consequence, they sometimes failed to effectively utilize and meaningfully incorporate technology to support student-centered instruction during microteaching. This result further extends the findings from prior studies (Lin *et al.*, 2021; Pellas, Mystakidis & Kazanidis, 2021) that iVR can act as a safe learning environment. However, teaching in iVR requires not only systematic training in teaching strategies but also strategies to increase teacher confidence and self-efficacy in using iVR.

Another possible reason for the undergraduate students' teacher-centered approach was that they taught as they were taught during secondary school. They reported that even though they disliked teacher-centered English classrooms during their school years, they did the same in microteaching because it was the most familiar method to them. Their remarks suggested that they may need a process of unlearning and relearning to become more competent teachers (Miller & Wu, 2022). Prior studies claimed that multiple factors (e.g. content, pedagogical and technological knowledge, attitudes and motivation towards technology use, and previous experiences) affect effective technology integration (Kim *et al.*, 2017; Tondeur *et al.*, 2021).

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Similarly, in the current study, the large gap between undergraduate and graduate students regarding teaching experience resulted in a gap in pedagogical and content knowledge and, ultimately, different outcomes in technology-integrating microteaching.

Based on the results, the present study proposes several pedagogical implications. Most importantly, the study indicated that merely having innovative technology did not guarantee effective teaching, and teachers' technological knowledge was not sufficient for good practice. Technology integration is a complex process, requiring multiple knowledge and capabilities, and knowing how to use technology in teaching – that is, technological pedagogical knowledge – is crucial to good practice (Tondeur *et al.*, 2021). Previous studies have claimed that despite technology courses in teacher education, preservice teachers often do not feel adequately prepared to effectively integrate technology into their classrooms and find a gap between their technological knowledge and good pedagogical practice (Kessler & Hubbard, 2017; Lee & Ahn, 2021). Good practice can be achieved only where content, pedagogical, and technological knowledge intersect. Hence, teacher education should foster their knowledge of content and pedagogy and help bridge the gap via various methods, such as observing models and participating in microteaching or field experiences. For instance, in the current study, as the graduate students outperformed the undergraduate students, watching the graduate students during microteaching in iVR would be helpful to the undergraduate students. As the participants in the present study realized the gap between their knowledge and practice during microteaching, engaging in microteaching will allow teachers to bridge the gap between technological pedagogical knowledge and practice to enhance their skills. Field experiences will be even more effective (Tondeur *et al.*, 2017).

Both preservice teachers and in-service teachers need more opportunities to learn new technologies and practice them. In the present study, the graduate students demonstrated good practice in microteaching using cutting-edge technology. However, this result cannot be generalized to all in-service teachers in Korea. Indeed, previous studies have noted that in-service teachers frequently lack opportunities to acquire and update technological knowledge and skills (Choi, 2020; Kim, Shin & Ryu, 2020). Since technology is rapidly advancing, teachers may feel uncomfortable or even fearful about the use of technology in education (Lin, Tsai, Chai & Lee, 2013). Similarly, Ertmer and Ottenbreit-Leftwich (2010) also mentioned that not only preservice teachers but also in-service teachers lack confidence in using technology. As Kessler (2021) pointed out, sufficient, appropriate, and adequate TELL preparation should be offered to cultivate teachers' ability to exert technological knowledge and skills for their own classroom purposes and help them build confidence in the long term, which will directly change future classrooms.

6. Conclusion

Technology use is not an option but an integral part of good teaching and good practice in the 21st century, as it has much potential to significantly augment student learning (Kessler, 2021). For effective technology use, teachers' TCs are essential. The present study showed that the challenges did not lie in adapting to technology but in pedagogy. It is human resources and effort that make technology use in education successful. The significance of the current study is to examine how pre- and in-service teachers incorporated iVR into practice. The added value of the study lies in the richer and more in-depth understanding of how technological pedagogical knowledge played a critical role in successful technological integration in the classroom through analysis of microteaching in iVR. While prior studies often relied on self-report questionnaires, the present study directly examined the participants' performance-based tasks, and this provided valuable insights into teacher education.

Although the study offered some useful implications, it was not flawless. The small sample size in this project limited the generalizability of the findings. However, as mentioned earlier, this shortcoming was caused partly by the limited number of users who can use Immerse at one time.

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It is thus advised that software engineers should consider the capacity of VR learning tools, especially when class sizes are generally large in Asian countries. Meanwhile, since the study drew upon qualitative data without quantitatively measuring increased TCs after microteaching in iVR, future research may benefit more from a mixed-methods approach. Additionally, design-based research could have been adopted with iterative cycles of identifying, developing, implementing, and refining the study based on student performances.

If technology use is unavoidable, then teachers are supposed to do well with technology in the classroom. We all have experienced difficulties to some extent in adopting technology during the sudden transition to online learning due to the pandemic (Teng & Wu, 2021). The undergraduate students in the present study encountered challenges when integrating technology into practice, which indicated the importance of TELL teacher preparation in teacher education. Teacher education programs therefore need to constantly update the curriculum, include emerging technologies, provide more hands-on practices, and thus better prepare teachers for future classrooms.

Ethical statement and competing interests. All participation in the study was voluntary and informed consent was obtained prior to the start of the study. Participants' anonymity was maintained throughout the study. The authors declare no competing interests.

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https://doi.org/10.1017/S0958344024000089 Published online by Cambridge University Press