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AI-integrated Mobile-assisted Language Learning: Is It an Effective Way of Preparing for the TOEIC Test in Classroom Environments?

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The purpose of this study was to examine the impacts of AI-integrated MALL on Korean students' TOEIC preparation, by comparing with AI-integrated CALL. A total of 496 freshmen students participated in this study. They were arbitrarily assigned to AI CALL (n = 190), AI MALL (n = 164), and the control (n = 132) groups. During a 2021 academic semester, the two experimental groups studied TOEIC through computers or mobile phones, integrated with AI technology. The control group was taught by a human teacher, in a traditional classroom setting. Before and after the treatment, TOEIC listening and reading tests were administered. Paired samples t-tests and one-way ANOVAs, were used to analyze collected data. Findings show that all groups significantly increased listening and reading test scores. Group comparison results show that the AI CALL group outperformed the control group for both tests. This group also outperformed the AI MALL group for the reading test. Based on this, pedagogical implications are invaluable.

Key words: AI, Language Learning, CALL, MALL, TOEIC

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1. INTRODUCTION

With the arrival of mobile technologies in the early 2000s, a new acronym, mobile assisted language learning (MALL), appeared. O'Malley et al. (2003) described MALL as "any sort of learning that happens when the learner is not in a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies" (p. 6). According to Kim, Cha, and Kim (2019), using mobile devices are a commonly accepted feature of modern life.

There has been increased interest in mobile technology to make it available to learn anytime and anywhere. It has allowed students to manage and control their own pace of learning regardless of time and place. As a matter of fact, portability is a unique feature of mobile devices. Particularly, when comparing mobile-assisted language learning with computer-assisted language learning (CALL), its portability feature is always noticed and appreciated (Yoon & Kim, 2020). According to Yamaguchi (2005), computers are better than mobile devices for processing various types of information including auditory, visual, and textual information, but mobile devices are superior to computers in portability.

In particular, online L2 learning programs have been utilized for TOEIC preparation in different ways using various types of technology. According to Shimada (2017), the majority of students in a TOEIC preparation course preferred the online learning program over the paper-based textbook. Stewart (2019) reported that the online TOEIC learning program can particularly be an effective learning resource for a CALL course. Recently, with the development of mobile technology, TOEIC programs have also been integrated with MALL, showing its positive effects on TOEIC score increase. Particularly, Kimura, Obari, and Goda (2011) reported L2 students equally benefited from MALL and CALL.

However, in Kimura et al.'s (2011) study, the online TOEIC program was a ready-made or pre-made lesson. This means that both the mobile or computer technology-integrated programs were preprogrammed and they provided immediate but previously made or preset feedback. Learning contents were neither customized nor individualized for the students. The students were not able to receive personalized suggestions for their learning. Furthermore, since the learning was prepared by the teachers, the online learning program placed a heavy burden on the teachers in preparing learning contents.

According to Brusilovsky and Miller (2001), the integration of artificial intelligence (AI) in online learning courses stands in opposition to this conventional "just-put-it-on-the-web" approach. AI incorporates either intelligent or adaptive systems or both for enhanced learning. For example, intelligent tutoring systems (ITS) incorporated with AI perform activities traditionally done by a human teacher. They coach students and diagnose their misconceptions (Brusilovsky & Peylo, 2003). They also attempt to provide learner-tailored support by implementing extensive modeling of the students' problem-solving process in a

specific domain (Magnisalis, Demetriadis, & Karakostas, 2011).

By adopting AI technology, adaptive educational systems (AES) also build a model of the knowledge, goals, and preferences of each individual student. They use the model while interacting with the student to adapt to his/her needs (Brusilovsky & Peylo, 2003). Therefore, they can operate differently for different students considering the different information accumulated in the individual learner models. In other words, AI enables personalized learning which can lead to successful academic outcomes. In this light, integrating AI programs in class seems necessary in educational settings (Kim, Kim, & Cha, 2022). By integrating AI into classrooms, it might solve the problem with conventional classrooms that prevail with a static and one-size-fits-all approach requiring all students to learn "the same information in the same structure using the same interface" (Wauters, Desmet, & Van Den Noortgate, 2010, p. 549).

As mobile technology advances, AI also becomes more and more popular. According to Liu, Diao, and Tu (2010), it is essential to integrate AI technology with mobile learning. For the next generation, the use of AI technology in mobile learning might be the key component of education. It might also be the survival skill required for 21st-century education (Obari & Lambacher, 2019). With mobile devices, AI learning has been experienced more efficiently and smoothly. The adoption of AI technology in mobile learning has transformed academic settings, enhancing the construction of broader educational environments (Kepuska & Bohouta, 2018). In order to improve mobile learning, it is important to adopt AI technology (Liu et al., 2010).

According to Hayashi and Sato (2020), AI-integrated mobile applications can be particularly beneficial for students of English. Previous empirical MALL studies have shown the positive effects of the integration of AI applications on English learning (Kim, Cha, & Kim, 2020; Kim, Kim, & Cha, 2021; Kim, 2018; Pham, Pham, Nguyen, Nguyen, & Cao, 2018). As Huang, Hew, and Fryer (2022) stated, AI applications seem to assist L2 learning in increasing listening, reading, writing, and speaking skills. The students can also benefit from those applications regarding their vocabulary and grammar skills.

According to Jones, Richards, Cho, and Lee (2018), most L2 students seek help from AI-integrated mobile applications for their English learning. In particular, they believe that the AI applications can help increase their official English test scores including TOEIC. Given that TOEIC is an important means for hiring new employees (Sirikanjanawong & Wasanasomsithi, 2018), AI-integrated programs seem to be of great help in increasing the students' TOEIC test scores. Previous scholars have also claimed that AI can act a beneficial role as an English tutor in increasing Korean students' TOEIC scores (Kim et al., 2020; Loh et al., 2021). By experiencing personalized learning including customized lectures and individual feedbacks, the students can enhance their English through AI programs (Kim et al., 2022).

Nonetheless, few experimental studies have been carried out to prove the effectiveness of AI in Korea. Although Liu et al. (2010) insisted that it is important to apply AI in mobile learning, little research has been conducted on mobile AI applications in L2 setting. Yang and Kim (2021) also pointed out that there is a lack of empirical evidence to confirm the efficacy of AI technology in English learning. Considering this, more AI studies are required to contribute to the literature regarding MALL. There is a need to elicit empirical evidence for the practical use and effectiveness of mobile AI applications in L2 classrooms. In this regard, the current study aims to explore the effects of the use of mobile applications integrated with AI technology on Korean students' TOEIC preparation, given the importance of the test in Korea (Kim, 2018).

Particularly, the study focuses on the effectiveness of AI-integrated MALL by comparing with AI-integrated CALL. As a sub-branch of CALL, MALL has drawn attention as a new topic in L2 settings (Kim, 2018). However, Yoon and Kim (2020) pointed out that trend might be just a trend and it should be noted that new technology is not always superior to previous ones. Thus, it is important to carefully examine whether the new learning models or approaches are actually better than the previous ones. Taking all into consideration, research questions are as follows:

1) To what extent does MALL integrated with AI technology influence Korean students' TOEIC listening and reading?
2) Are there any different effects on students' TOEIC scores after engaging in AI-integrated MALL and AI-integrated CALL?

2. LITERATURE REVIEW

2.1. CALL to MALL

The development of the internet technology has particularly facilitated computer-assisted language learning (CALL). With CALL programs, language learning has been promoted all over the world (Webb & Doman, 2016). According to Chapelle (2009), CALL is fully capable of enhancing L2 acquisition by increasing opportunities for input, output, interaction, and feedback. Research findings on CALL have shown its positive impacts on L2 vocabulary (Smith, 2004), grammar (Fiori, 2005), pronunciation (Seferoglu, 2005), reading (Taylor, 2006), writing (Suh, 2002), and so on. According to Bax (2003), L2 classrooms in Korea reached the normalization stage of CALL to a certain extent. In other words, CALL became invisible and truly integrated in Korean L2 classrooms (Lee, 2019).

However, computers are not the only technology for language learning. As a sub-branch

of CALL, mobile-assisted language learning (MALL) has also caught the attention as a popular topic of interest in L2 teaching and learning (Kim, 2018). Insights from CALL have been used to inform learning activities presented through mobile phones (Kukulska-Hulme, 2006). Recently, the term mobile has been associated with mobile phones. As a miniature form of PCs, phones have an additional benefit of portability that surpasses laptop computers. According to Kukulska-Hulme (2009), this leap of technology from lap to palm has facilitated language learning in the hands of both teachers and their students. With the development of wireless mobile network, now it is possible to learn a language anywhere and anytime.

Kimura et al. (2011) investigated mobile technologies and language learning in Japan where TOEIC was so popular that it is widely used by companies and government agencies. Once the participants accessed the program online through mobile phones or computers, the uploaded TOEIC questions including multiple-choice questions with answer keys were delivered. They were mainly comprised of drill-and-practice programs for vocabulary and grammar. Once the participants downloaded and solved the questions, their answers were scored and the scores were sent to the participants. Using a Learning Management System (LMS), it was able to monitor the participants' learning progress and incorrect answers. Based on this, the participants received immediate feedback regarding their TOEIC learning. The study also found that both MALL and CALL groups improved in the participants' TOEIC scores. No statistically significant difference was found between the groups. In other words, Japanese students of English benefitted from online TOEIC programs either through mobile phones or computers.

Despite the existence of MALL studies on various aspects and skills of a language, the literature still lacks sufficient research studies investigating its effects on L2 learning. Many studies have focused on the effects of mobile devices regarding vocabulary and grammar learning (Kim, 2018). In particular, most MALL studies used SMS, MMS or e-mail. According to Okumuş Dağdeler, Konca, and Demiröz (2020), mobile applications involve audio and visual features, and it is necessary to investigate the effects of mobile learning on language learning through mobile applications which include these features. Nonetheless, common MALL applications available now are still dictionaries, flashcards, vocabulary games, and translators, and most MALL activities are related to vocabulary or grammar memorization by repetition and drills (Mindog, 2016).

In particular, little research attention has been drawn to the rapidly emerging phenomenon of Korean students' English learning with technology (Lee, 2019). Furthermore, although Bax's (2003) normalization of CALL was realized in L2 classrooms in Korea to a certain extent, technology has not been fully utilized beyond the traditional classroom (Lee, 2019). Taking all into account, more research is essential to contribute to the literature, eliciting empirical evidence for the effectiveness and practical use of mobile technology. It should be

discovered more considering the benefits of MALL to education system (Okumuş Dağdeler et al., 2020). Therefore, this study explores the effects of MALL on L2 learning in Korea. In particular, given that there is a dearth of studies exploring mobile learning integrated with AI technology, the current study aims to explore the effects of AI-integrated mobile applications on Korean students' English learning.

2.2. AI Technology in Language Learning

Liu et al. (2010) claimed that it is required to apply AI in mobile learning. According to them, it is an important way to improve mobile learning. Particularly in L2 contexts, AI should be implemented to assist language learning as it can increase learners' listening, reading, writing, and speaking skills as well as vocabulary, grammar, critical thinking, and meaning negotiation skills (Huang et al., 2022). In this regards, some empirical studies have examined the effectiveness of AI technology in mobile learning in L2 settings. The previous experimental studies have revealed that AI can positively enhance students' English learning (Goda, Yamada, Matsukawa, Hata, & Yasunami, 2014; Hayashi & Sato, 2020; Kim et al., 2020; Kim et al., 2021; Kim, 2017, 2018; Pham et al., 2018; Xu, Wang, Collins, Lee, & Warschauer, 2021; Yang & Kim, 2021).

To be specific, Goda et al. (2014) discovered that AI technology can help L2 students to learn critical thinking skills. By asking the students to clarify their ideas on the topic, it helps the students to organize their thoughts and engage in difficult problems. In their study, the participants showed significant improvement in critical thinking skills, especially regarding their awareness of critical thinking. Another example can be found in Kim's (2017) study, indicating that interactions with AI using mobile devices has promoted L2 learners' meaning negotiation skills. She reported that the students increased negotiation moves and used more negotiation strategies after practicing their speaking with AI applications. As meaning negotiation is positively related to learners' communication skills (Ko, Schallert, & Walters, 2003), she concluded that AI can be effectively used to improve L2 learners' language proficiency.

Pham et al. (2018) introduced a mobile application in which an AI technology was integrated. The authors reported that this AI application encouraged L2 learners to review daily lessons by interacting with the AI agent. The learners were provided with opportunities to have small talk in English and take quizzes relevant to the vocabulary and grammar lessons. Kim et al. (2021) examined how AI-integrated mobile applications affect L2 students' speaking skills and reported significant improvement in two speaking tasks: reading a text aloud and responding to questions. They suggested that students can increase their pronunciation, intonation and stress, as well as fluency with AI technology.

Kim et al. (2020) also investigated the effects of mobile interactions with AI on L2 writing

performance and found statistically significant improvement of the participants. The authors also reported the positive changes in participants' attitudes toward English learning. Their anxiety levels declined as a result of joining the mobile interactions with AI. Hayashi and Sato (2020) also reported that the students can reduce their anxiety while increasing their motivation and interests in English learning with AI. Yang and Kim (2021) added that students feel positive about AI technology for their English learning. This is in line with the earlier study (Jia, 2008), reporting that AI can make L2 students more confident and more interested in language learning.

Regarding English listening skills, Jia (2008) reported that AI technology improved L2 students' listening ability, made the students more confident, and enhanced their interest in language learning. In an effort to explore the effects of learning with AI agents on English listening and reading skills, Kim (2018) conducted an empirical study in an L2 classroom in Korea. For the 16-week experimental period, the participants engaged in English learning with AI agents. Her findings revealed that the participants significantly improved both TOEIC listening and reading skills. She concluded that L2 students benefitted from AI-driven English class.

According to Jones et al. (2018), it is now quite common for L2 students to seek help from AI technology in their English learning. In particular, they depend on AI and even think that teachers are no longer needed to increase their TOEIC scores. *Santa TOEIC*, for example, has played a beneficial role as an AI tutor in increasing the students' TOEIC scores in Korea (Kim et al., 2020; Loh et al., 2021). In Japan, the two AI applications, *Google Home Mini* and *Amazon Alexa*, have been considered to be useful for enhancing the TOEIC level (Obari, 2020; Obari & Lambacher, 2019; Obari, Lambacher, & Kikuchi, 2020). Another AI application named *Listening for the TOEIC Test* has also helped Indonesian students to increase their TOEIC skills (Kusumaningrum & Pertiwi, 2021).

According to Lam and Lawrence (2002), the incorporation of AI in class has redefined the roles of students and teachers. AI programs provide language students with the flexible environment where they can control their learning. They allow the students to choose their pace and path of learning, promoting the development of decision making skills. This leads to the enhancement of their learning autonomy. The students can be more active learners rather than passive recipients of knowledge. As they become more responsible for their learning, the students can also be independent learners.

Despite of the increased use of AI technology in L2 learning, there have been not so many experimental studies on the effectiveness of AI applications in Korea. Although the adoption of AI in mobile learning is necessary (Liu et al., 2010), few studies have been carried out on mobile AI applications. Yang and Kim (2021) also noted that sufficient empirical evidence is requested to prove the efficacy of AI applications in English learning. In this regards, the current study explores the effects of AI applications on Korean students' English learning,

focusing on their TOEIC score improvement.

3. METHODOLOGY

3.1. Subjects

The subjects of the current study were 486 college students at a university in Korea. They were all freshmen students majoring in various disciplines such as art, animation, applied music, design, police administration, fire administration, social welfare, and so on. The students were selected because they were required to take a TOEIC course to graduate from the university. All of them were new to and had no experience taking the TOEIC test. They were randomly assigned to one of the twenty sections of the course.

TABLE 1

Homogeneity Test

Group / Pre-test	AI CALL (*n* = 190)		AI MALL (*n* = 164)		Control (*n* = 132)		*F*	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*		
Listening	145.26	48.69	148.11	40.53	142.27	42.27	0.635	.530
Reading	194.84	64.69	182.74	50.12	175.91	59.92	0.547	.579

The researcher of the study arbitrarily selected seven sections as an experimental group one (AI-integrated CALL group), seven sections as an experimental group two (AI-integrated MALL group), and the other six sections as a control group. The first experimental group (AI CALL, hereafter) consisted of 190 students while the second experimental group (AI MALL, hereafter) was comprised of 164. The control group was composed of 132 students.

In order to determine whether there were significant group differences among the three groups in listening and reading skills, the TOEIC listening and reading tests were employed before the treatment. As shown in Table 1, regarding the listening pre-test administered at the beginning of the study, no statistically significant group difference was found ($F = 0.635$, $p = .530$). Likewise, for the reading pre-test, mean score difference among the groups turned out to be statistically insignificant ($F = 0.547$, $p = .679$). It was expected that the three groups were homogeneous at the beginning of the research. Furthermore, all participants had no experience studying English with AI before.

3.2. Materials

In the current study, pretest-posttest design with control group was used to evaluate the effects of the use of AI-integrated mobile applications on Korean students' TOEIC learning. In order to compare the pre-test and post-test scores, all the participants in the current study were required to take the TOEIC listening and reading tests as pre-tests at the beginning of the study. After the treatment, at the end of the study, all of them took the same tests as post-tests.

The tests questions were selected from an official TOEIC test preparation book by ETS, *Tactics for TOEIC Listening and Reading Test.* The students' test scores were predicted by the number of correct answers. For each section, scores ranged from 0 to 100. One credit was assigned to one correct answer. The students received total scores within a range of 0 to 200. Their test scores were then applied to the TOEIC Conversion Table by Waikato Institute of Education (from http://wie.ac.nz/toeicconversion.htm). The students were given their final scores on a scale ranging from 10 to 990, based on the conversion table. According to Mason and Krashen (2014), scores from the table relate TOEIC levels with real-world competence.

3.3. Procedures and Statistical Analysis

The purpose of the current study was to explore the effects of AI-integrated MALL on Korean students' TOEIC learning. For the study, students in the two experimental groups accessed an AI-integrated TOEIC learning program through their computers or mobile phones to complete the tasks that AI has assigned to them. While the AI CALL group joined the class through their computers, the AI MALL group used mobile phones to take the class.

The AI program adopted for the current study was *Soljam* (www.soljam.net). This program included diagnostic tests, score predictions, lectures, explanations, reviews, and so on. Based on a student's diagnostic test results, *Soljam* learned the student's current level and desired level. The program enabled adaptive learning by analyzing the student's weakness and offered the most optimized learning path. It analyzed students' learning data to deliver complementary exercises and lesson plans. The more the students joined the program, the more it learned. It became able to predict and assess the students' future learning behavior more precisely.

Based on the student's data, the AI program provided tailored lectures, customized explanations, and personalized practice tests. In the current study, therefore, the participants were not taught the same curriculum. The students had a personalized learning experience through the AI-integrated program. It can be said that the program offered an AI tutor to every student. Progress was different from student to student. In addition, there was a difference in the amount of learning. Activities were automatically recommended and

adapted according to the students' needs and progress. The participants accessed their suggested exercises through computers or mobile phones. Tips and strategies for a higher TOEIC score were also given with individualized feedbacks. As Kim et al. (2022) suggested, having AI tutoring every student seemed a scalable solution.

For the control group, traditional teaching methods were adopted. A paper-based textbook, *Longman Preparation Series for the TOEIC Test* (Lougheed, 2017), was used for the class led by a human teacher. There were practice items reflecting the format and content of the TOEIC test. Test-taking tips were also provided with test-related grammar and vocabulary. Based on the textbook, the teacher provided face-to-face explanation. Students were allowed to take hand-written notes on the textbook. As the main class objective of the traditional classrooms was to pass the examination (Joshi, 2018), the teacher encouraged the students to recite what they have learned for reflection (Curtis, 2006). In the current study, the students reviewed their notes to memorize them after the class.

In the study, the students were also allowed to ask questions during the class. As Gall (1984) noted, in the traditional classroom, the teacher's questions and students' answers were the mainstream of teacher-student interaction. However, it was also initiated by questions from the students asking about the TOEIC tests. According to Joshi (2018), the teacher-student interaction is active in the traditional classrooms, which can help enhance students' learning.

Although the whole treatment was conducted during the pandemic, COVID-19, the university provided face-to-face teaching. The epidemic situation around the university was relatively not serious having fewer confirmed cases than other locations. Thus, the school forced their students to take offline classes. Furthermore, as it was a newly developed course incorporating AI technology, the class was also held in an actual classroom. With the teacher's guidance, the participants in the experimental groups took a class at a fixed time.

3.4. Statistical Analysis

At the beginning and the end of the semester, students' pre- and post-test scores were collected and taken as a primary data for the study. Descriptive statistics including means and standard deviations were computed for all the test results. In order to compare the listening and reading pre-test and post-test scores, paired samples *t*-tests were administered. The purpose was to assess whether there were significant mean score change in students' TOEIC listening and reading tests. Then, a one-way ANOVA was administered to compare the participants' listening and reading post-test scores by group. The purpose was to determine whether there were significant group differences in post-test scores. If statistically significant differences were witnessed, Bonferroni post-hoc tests were carried out to find out which group performed better than others. Significance level was set at .05.

4. RESULTS

4.1. Effects on TOEIC Listening and Reading Scores

At the beginning of the current study, all participants took part in TOEIC listening and reading pre-tests. All of them also took the same TOEIC listening and reading tests as post-tests at the end of the study. For each group, descriptive statistics such as means and standard deviations were computed. The purpose was to compare the pre-test and post-test scores. Paired samples *t*-tests were conducted to assess whether there was a significant change in students' listening and reading scores.

TABLE 2

Listening Pre-and Post-tests

Group	Pre-test		Post-test		*t*	*p*
	M	*SD*	*M*	*SD*		
AI CALL (*n* = 190)	145.26	48.69	194.84	64.69	-15.638	.000
AI MALL (*n* = 164)	148.11	40.53	182.74	50.12	-9.640	.000
Control (*n* = 132)	142.27	42.27	175.91	59.92	-7.179	.000

The listening test results are first presented in Table 2 above. For the students engaged in CALL with AI, the mean score of the pre-test was 145.26 (*SD* = 48.69) while that of the post-test was 194.84 (*SD* = 64.69). The students in AI MALL group scored 148.11 (*SD* = 40.53) on the average for the pre-test while they received 182.74 (*SD* = 50.12) for the post-test. The mean score of the pre-test for the control group was 142.27 (*SD* = 42.27) while that of the post-test was 175.91 (*SD* = 59.92). From the descriptive statistics, it was found that all the three groups increased their listening scores from the pre-test to the post-test.

The findings of the paired-samples *t*-tests revealed that the mean score differences between the pre-test and the post-test were statistically significant for all the three groups: AI CALL, AI MALL, and the control groups. To be specific, it was found that there was a positive change in students' test scores for AI CALL group (t = -15.638, p = .000). Likewise, the mean score change for the students who engaged in MALL with AI was turned out to be statistically significant (t = -9.640, p = .000). For the control group, a significant difference was also witnessed between the pre- and post-tests (t = -7.179, p = .000). Overall, it can be said that there was a significant increase in students' TOEIC listening skills for all the three groups.

TABLE 3

Reading Pre-and Post-tests

Group	Pre-test		Post-test		*t*	*p*
	M	*SD*	*M*	*SD*		
AI CALL (*n* = 190)	194.84	64.69	222.16	56.79	-16.679	.000
AI MALL (*n* = 164)	182.74	50.12	197.32	62.65	-9.382	.000
Control (*n* = 132)	175.91	59.92	186.67	66.31	-5.653	.000

Table 3 above presents the reading test results. From the descriptive statistics, it was found that the students in AI CALL group scored 194.84 (*SD* = 64.69) for the pre-test while they received 222.16 (*SD* = 56.79) for the post-test. For the students who engaged in MALL with AI, the mean score of the pre-test was 182.74 (*SD* = 50.12) while that of the post-test was 197.32 (*SD* = 62.65). The mean score of the pre-test for the control group was 175.91 (*SD* = 59.92) while that of the post-test was 186.67 (*SD* = 66.31). The descriptive statistics showed that all the three groups increased their reading scores from the pre-test to the post-test.

The findings of the paired-samples *t*-tests indicated that the mean score differences between the pre-test and the post-test were statistically significant for all the three groups: AI CALL, AI MALL, and the control groups. Specifically, the mean score change from the pre-test to the post-test for the students engaged in CALL with AI was turned out to be statistically significant (t = -16.679, p = .000). Accordingly, it was found that there was a positive change in students' reading test scores for AI MALL group (t = -9.382, p = .000). For the control group, a significant difference was also observed between the pre- and post-tests (t = -5.653, p = .000). In general, it can be seen that there was a significant increase in students' TOEIC reading skills for all the three groups.

To sum up, this study confirmed the positive effects of both MALL and CALL on L2 listening and reading when integrated with AI technology. To be specific, the findings of the paired-samples *t*-test revealed that the participants in AI MALL and AI CALL groups increased their TOEIC listening and reading test scores after the treatment. It was found that L2 students in Korea benefitted from either AI-integrated MALL or AI-integrated CALL regarding their English listening and reading skills.

Interestingly, however, the control group also showed a statistically significant increase in TOEIC scores. It was found that the traditional teaching methods were still beneficial for L2 students studying TOEIC. It can be said that human teachers still play a role in increasing students' language skills. These findings are discussed in the next section in detail.

4.2. Group Difference in Effects on TOEIC Scores

At the end of the current study, all participants took TOEIC listening and reading post-tests. In order to compare the participants' post-test scores, a one-way ANOVA was administered. The purpose was to examine whether the effects significantly differed by group. In other words, it was to determine which group significantly performed better than the other groups. Table 4 below indicates the results of the ANOVA and the descriptive statistics including means and standard deviations for the results of the listening and reading post-test scores.

TABLE 4

ANOVA Test

Group / Post-test	AI CALL		AI MALL		Control		*F*	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*		
Listening	194.84	64.69	182.74	50.12	175.91	59.92	4.331	.014
Reading	222.16	56.79	197.32	62.65	186.67	66.31	14.503	.000

A one-way ANOVA was conducted to determine whether there was a group difference in students' listening and reading test scores. As can be shown from Table 4 above, there were significant group differences found in both the listening post-test (F = 4.331, p = .014) and the reading post-test (F = 14.503, p = .000). Therefore, post-hoc tests were then carried out to find out which group performed better than others. The Bonferroni post-test results are presented in Table 5 below.

TABLE 5

Post-hoc Test

Test	Group	*MD*	*SE*	*p*
Listening	AI CALL > Control	18.93	6.66	.014
Reading	AI CALL > AI MALL	24.84	6.55	.001
	> Control	35.49	6.97	.000

As can be seen in Table 5, there were significant group differences observed in both listening and reading test scores. In particular, for the listening test, students who engaged in CALL with AI scored higher than those in the control group (MD = 18.93). The mean score difference between the two groups was turned out to be statistically significant (p = .014). For the reading test, the same result was obtained. AI CALL group significantly performed better than the control group with the mean score difference of 35.49 (p = .000). Furthermore, the students in AI CALL group outperformed those in AI MALL group for the reading test

(*MD* = 24.84). The mean score difference between the two groups appeared to be statistically significant (p = .001). Interestingly, significant differences were not found between AI MALL group and the control group for both the listening and reading tests. Group difference between AI-integrated CALL and AI-integrated MALL also appeared to be statistically insignificant for the listening test. It can be seen that Korean students benefitted from AI-integrated TOEIC programs either through mobile phones or computers.

To sum up, the findings of group comparison revealed that there were significant differences in both listening and reading post-test scores depending on experimental condition. For the listening post-test, the students who engaged in CALL with AI showed better performance than those in the control group. In other words, the students who experienced AI technology through a computer outperformed those who did through a mobile phone. Similarly, AI CALL group performed better than the control group in reading. They scored higher for the reading post-test at a significant level of .05.

Interestingly, there were no statistically significant differences found between AI MALL group and the control group for both the listening and reading post-tests. No group difference was also found between the AI CALL and AI MALL groups for the listening post-test. However, a statistically significant difference was also found between the two experimental groups for the reading post-test. It was found that the students benefitted more from AI-integrated CALL than from AI-integrated MALL. It seemed more beneficial to engage in AI-integrated class using computers than using mobile phones.

5. DISCUSSION

5.1. Positive Changes in TOEIC Listening and Reading Scores

AI applications have been considered to be useful for L2 learning. In Japan, for example, a number of scholars have proved their effectiveness in listening and reading skills (Obari, 2020; Obari & Lambacher, 2019; Obari et al., 2020). In Taiwan, Hong, Huang, Hsu, and Shen (2016) also reported the obvious progress in students listening and reading skills after using the AI technology in L2 class. The researchers concluded that AI applications are beneficial education tools in improving English listening and reading skills. In Korea, students have shown the strong need for AI applications when studying English (Jones et al., 2018). According to Kim (2018), the students can benefit from the AI technology especially regarding their listening and reading skills. In particular, the previous scholars claimed that AI applications play a beneficial role in increasing Korean students' TOEIC listening and reading scores (Kim et al., 2020; Loh et al., 2021).

The findings of the current study corroborate the previous studies indicating the positive

effects of the use of AI mobile applications on L2 listening and reading (Hong et al., 2016; Jones et al., 2018; Kim et al., 2020; Kim, 2018; Loh et al., 2021; Obari, 2020; Obari & Lambacher, 2019; Obari et al., 2020). In the present study, the findings of the paired-samples *t*-test revealed that the participants in AI MALL and AI CALL groups increased their TOEIC listening and reading test scores after the treatment. It was found that L2 students in Korea benefitted from either AI-integrated MALL or AI-integrated CALL regarding their listening and reading skills.

Interestingly, the study found that the control group also significantly increased their TOEIC scores. The main objective of traditional face-to-face classrooms is to pass the examination (Joshi, 2018). Therefore, in the conventional classrooms, there is more discipline compared to the modern, technology-integrated classrooms. Teachers encourage recitation for learner reflection (Curtis, 2006). Students are asked to take notes while taking a class and review their notes to memorize them after the class. The teachers in the traditional classrooms can focus more on their teaching since they do not need to have any special technical knowledge. This might result in the significant increase in TOEIC scores of the students in the control group.

The main purpose of the present study, however, was to investigate whether MALL integrated with AI technology is more effective than AI-integrated CALL in learning English. The control group was, thus, used to provide a baseline of the typical performance of students who had not experienced the AI technology during the experimental period.

5.2. Group Differences in TOEIC Listening and Reading Scores

The current study also discovered that it was only the AI CALL group that more increased listening and reading test scores than the control group. The AI MALL group failed to show better performance in both the listening and reading tests compared to the control group. In addition, the students in the AI CALL group scored higher than the AI MALL group for the reading test. Regarding the superior effects of AI-integrated CALL over AI-integrated MALL on reading post-test scores, the current study confirms that L2 students benefit more from CALL than from MALL. Regarding the listening post-test scores, however, there was no significant difference between the two experimental groups: AI CALL and AI MALL groups.

Regarding the comparison between AI CALL and AI MALL groups, the findings of the present study are in accordance with the previous ones in L2 settings in one way. However, in another way, the findings are different from the previous ones. Kimura et al. (2011) reported that both CALL and MALL groups improved in TOEIC listening and reading scores. However, they found no statistically significant difference between the two experimental groups for both the listening and reading post-tests. It was found that either through mobile

phones or computers, the students in their study were able to benefit from online TOEIC programs in terms of both their listening and reading skills. Considering the insignificant difference in the listening post-test scores between AI CALL group and AI MALL group for the current study, the findings corroborate the previous research. Given the significance difference in the reading post-test scores between the two groups, however, the findings of the study oppose this previous research (Kimura et al., 2011).

Portability is the most prominent feature of mobile devices. When comparing mobile-assisted learning with computer-assisted learning, this portability feature is always noticed and appreciated (Yoon & Kim, 2020). Aside from portability, mobile devices provide many advantages regarding accessibility, usability, and flexibility with features of low cost, light weight, and hand-held size. Furthermore, with functions of voice recording and inbuilt cameras, mobile devices help students obtain both oral and visual information. In this regard, Thornton and Houser (2005) claimed that mobile devices are effective and efficient when delivering language learning materials to the students.

However, it is also necessary to note that the effects of MALL particularly depend on disturbances of many kinds. For example, it is subject to network connectivity standards that may not always provide very high transmission capacity. Some particular carriers even have a lack of networks all the time and there may be geographical limitations (Kimura et al., 2011). Moreover, mobile devices have small screen size, restricted memory, and limited presentation of graphics (Kim & Albers, 2001). This might result in the superior effects of AI CALL over AI MALL on L2 students' reading skills in the current study. The students in the AI MALL group might have had trouble with reading passages on mobile phones with small screen size with a lack of networks.

Yamaguchi (2005) also noted that mobile devices are only superior to computers in portability. According to him, computers are better than mobile devices for processing various types of information including auditory, visual, and textual information. Sung and Mayer (2012) also reported that students viewed computers as more stable, faithful, concentrative, and essential than mobile devices, which may affect their learning. Taking all this into consideration, it can be said that CALL integrated with AI can be more beneficial than MALL with AI regarding L2 students' reading skills.

Interestingly, in the present study, the AI MALL group did not show better performance in both the listening and reading compared to the control group with a human teacher in a traditional classroom. Salaberry (2001) claimed that it is unclear that all technology has the same pedagogical advantages as traditional and conventional language classroom instruction. In particular, mobile technology may not justify its expense (Fallahkhair, Pemberton, & Griffiths, 2007). The same or similar learning outcomes can be achieved through desktop computers, TV programs, or even textbooks. Considering the fact that AI MALL group failed to show the superior effect over the other two groups in the current study, it should be

noted that new technology is not always better than previous ones.

According to Salem and Mohammadzadeh (2018), students still want to be traditionally taught by human teachers. For the students, the teachers are not just vehicles to deliver learning content. Rather they are agents who can change lives of the students. Furthermore, presence of teachers leads to direct teacher-student relationship. It has many positive effects on teaching and learning process including learner motivation (Nneji, 2014). In the present study, it was also found that the traditional teaching methods were still beneficial for L2 students studying TOEIC. The findings of the current study revealed that human teachers still play a significant role in increasing students' language skills. In this light, it can be said that the study confirmed the educational value of the traditional teaching methods with human teachers. These results suggest that the positive performance of students in previous MALL studies might have been overestimated. In the same line, the gains in MALL classes where AI was incorporated with AI might be due to the novelty of the tools, contents or methods rather than the incorporation of AI in MALL itself.

6. CONCLUSION

As AI becomes popular, the adoption of AI technology in mobile learning has been regarded as a prerequisite in educational settings (Liu et al., 2010). In L2 contexts where TOEIC is a high-stake test, scholars have claimed the positive effects of AI-integrated MALL on TOEIC preparation (Hong et al., 2016; Jones et al., 2018; Kim et al., 2020; Kim, 2018; Loh et al., 2021; Obari, 2020; Obari & Lambacher, 2019; Obari et al., 2020). In this regards, the current study aimed to explore the effectiveness of AI-integrated MALL in preparing TOEIC tests. The findings of the current study offer empirical evidence to support these previous studies. Considering that there is a lack of experimental research studies, this study proves the educational value of AI mobile applications in L2 settings.

Furthermore, the current study compared the effects of AI-integrated CALL and AI-integrated MALL on L2 students' TOEIC preparation. By comparing to CALL integrated with AI technology, the study investigated the effects of MALL with AI on the students' TOEIC listening and reading scores, and the findings revealed the superior effects of CALL over MALL on reading. Regarding listening, insignificant difference between AI CALL and AI MALL groups was found in accordance with the previous research (Kimura et al., 2011), suggesting that L2 students can benefit from either CALL or MALL.

More importantly, this study found that AI MALL group failed to show better performance than the control group in both listening and reading. As Salaberry (2001) stated, it was not clear that technology has the same pedagogical advantages as traditional and conventional language classroom instruction. Furthermore, the current study suggests that

new technology (e.g., mobile technology) is not always better than the previous one (e.g., computer technology). In particular, mobile phones have limitations such as small screen size and restricted memory aside from unstable network problem. This also might result in the superior effects of AI CALL over AI MALL on L2 students' reading skills.

Taking all into consideration, the findings of the current study may provide guidance for further developments or improvements in using AI mobile applications. Based on the results of the study, several pedagogical implications can be made. L2 students can increase their TOEIC scores by engaging in AI-integrated TOEIC learning programs. They can use either computers or mobile phones to increase their TOEIC listening and reading test scores. In particular, using computers seems more beneficial for increasing reading skills. Therefore, teachers should carefully consider using AI-integrated programs through computers rather than mobile phones in L2 reading class.

According to Riasati, Allahyar, and Tan (2012), technology should be employed in language class to enhance learning and teaching. Therefore, language teachers should consider using technology to be instrumental in language instruction. In particular, the current study suggests that the language teachers should explore the integration of AI in classrooms. However, the teachers need to be concerned about excessive reliance on technology use. Furthermore, they should consider barriers preventing an even distribution in technological resources. According to Maskey (2020), it should be carefully considered how to overcome them.

Moreover, the teachers should understand that it is still unclear that technology offers the same pedagogical advantages in language learning as the traditional classroom instruction does (Salaberry, 2001). Particularly, the teachers should be aware of the fact that newly developed technology is not always superior to the previous ones. They should be careful when investing time and money in new and unproven technologies. It is important to make sure that the teachers are fully prepared and empowered to leverage AI. Assuming these elements are addressed, the possibilities of AI-powered learning are infinite.

In addition, teachers should understand that students have different learning styles (Dörnyei & Ryan, 2015). As Shimada (2017) reported, not all students can enjoy online TOEIC learning. There might be some students who prefer paper-based textbooks to computers or mobile phones. Furthermore, considering the fact that the actual TOEIC is still administered on a paper with a pencil, paper-based exercises can be more motivating to students (Yamamoto, 2021). Therefore, TOEIC learning programs should be administered considering the students' different needs and learning styles. It might be better to mix different types of teaching materials and resources to help the students increase TOEIC scores.

Limitations and suggestions for future study are also made. First, the present study found that all participants increased their listening and reading test scores from the pre-test to the

post-test. In other words, all the three groups including the control group benefitted from each intervention. This result can be explained by the general practice effect as the participants retook the same test. Practice effect is known as an improvement in performance attributed to having previously performed the same or similar test (Valovich, Perrin, & Gansneder, 2003). Due to the equivalent and marginal test-retest practice effect, all groups including the control group might have been able to improve numerically on the post-test. Therefore, the findings should be carefully interpreted taking into account the practice effect.

Furthermore, the participants in the current study did not take advantage of using mobile phones. Although the students used their mobile phones to join the AI-integrated TOEIC learning program, the class was also held in an actual classroom at a fixed time. Since it was a newly developed course incorporated with AI technology, the students were forced to take offline classes under the teacher's control. Given that the one of the biggest advantages of MALL is anytime anywhere learning (Kukulska-Hulme, 2009), the AI MALL group did not fully utilize its flexibility of time and place. In other words, the students in the AI this group used mobile phones to take a class but did not benefit from learning regardless time and place. There might be different results if the students were allowed to join the AI-integrated program outside the classroom whenever they wanted.

Lastly, in order to investigate more detailed difference between AI-integrated CALL and AI-integrated MALL, qualitative methods of analysis can be carried out. Data can be collected through class observation reports and in-depth interviews from both students and teachers. For example, class observation can be employed to carefully observe what is happening during the AI-integrated class. Interview results can provide insights into the AI-integrated programs from students' and teacher's points of view.

Applicable levels: Tertiary

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