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The impact of mobile-assisted project-based learning on developing EFL students' speaking skills

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Abstract

Combining mobile-assisted language learning (MALL) with project-based learning (PBL) might be the potential framework for enhancing EFL learners' speaking skills. However, only a few studies have scrutinised the impact of modern technologies on project work. More importantly, investigating how MALL, as a new field within ICT with unique pedagogical affordances, and PBL can enhance learners' speaking skills is still lacking in the literature. Accordingly, this study examines how integrating MALL through mobile phones and PBL, defined as mobile-assisted project-based learning or mobile-assisted projects, improves Moroccan secondary school students' speaking performance. A true experimental study was conducted with 91 students assigned randomly to one experimental group and two control groups. The experimental group received instruction through mobile-assisted projects over one semester. In contrast, participants in the first control group taught speaking through project-based learning, and participants in the second control group received traditional teaching. Two instruments were employed to collect data: a speaking pre- and post-test to evaluate the three groups' oral proficiency and a 5-Likert scale survey to detect the experimental group participants' experience and attitudes toward the implementation. Based on independent sample *t* tests and paired sample *t* tests (SPSS-26), it was found that instruction through mobile-assisted projects was considerably more effective than project-based learning and conventional teaching in enhancing learners' overall speaking performance and sub-skills: fluency and coherence, lexical resource, grammatical range and accuracy, and pronunciation. Further, the results of the attitude post-questionnaire demonstrated a very high positive perception of the participants toward the implementation. As a result, these findings confirm the pedagogical role of combining MALL with PBL as an innovative mode of instruction in enhancing EFL learners' speaking performance.

Keywords: EFL learners, MALL, Mobile-assisted project-based learning, PBL, Speaking skills

Introduction

Speaking skill is key in the language learning process and output (Hughes, 2011). Many, if not most, EFL students primarily focus on improving their speaking skills (Pawlak & Waniek-Klimczak, 2015). Speaking ability is described by Ur (2012) as the faculty that

includes all other kinds of knowledge, and "people who know a language are referred to as 'speakers' of that language" (p. 117). Mastering speaking allows learners to communicate with others and express their opinions, thoughts, and feelings. Besides, according to Westrup and Baker (2003), speaking proficiency increases learners' chances of receiving higher education degrees, getting proper jobs, and getting quick promotions.

However, according to Brown and Yule (1983), speaking is the most challenging skill, given that speakers should listen to their partners to understand the spoken communication and respond in the target language. In this process, learners encounter significant problems, such as personal (e.g., nervousness, hesitation, and anxiety), linguistic (e.g., lacking vocabulary and grammar mistakes), social (e.g., fear of making mistakes and criticism), and environmental, mainly conventional teaching methods (Asratie et al., 2023; Chand, 2021).

To stimulate EFL speaking, recent evidence has proven the effectiveness of PBL in providing various options and opportunities to support learners and overcome the difficulties above (Fitriati & Mafruudloh, 2020; Suryani & Argawati, 2023; Zhang & Ma, 2023). Research has also recognised that project work boosts students' decision-making and leadership skills (Hasanah et al., 2023; Matilainen et al., 2021), autonomous and collaborative learning (Chi, 2023; Imbaquingo & Cárdenas, 2023; Khoudri et al., 2023), creativity and creative thinking (Khafah et al., 2023; Khoiri, 2023; Latifaj, 2023), and problem-solving abilities (Gawade et al., 2023). Thus, PBL is a comprehensive approach that emphasises meaningful improvement of lifelong and language skills (Beckett & Slater, 2018a).

In PBL, technology dramatically assists in designing the project in its different phases, creating ground-breaking ideas, and sharing the final product. Students can use technology tools, software, and instant text messaging to complete parts of their projects (Beckett & Slater, 2018b). Web applications make it easier to communicate and collaborate with people outside the classroom walls. Moreover, technology helps teachers assess the final product and mediate student-student and student-teacher interactions. Thus, technology is a backdrop for enhancing students' productivity and social interaction (Postholm, 2006).

In this regard, among the latest modern technologies that can be used in PBL is mobile technology. Mobile technology devices make learning a language more accessible and manageable. Learners can practice the target language more actively and get feedback about their progress (Kukulka-Hulme, 2020). Mobile devices also enhance teaching productivity by facilitating better planning and quick assessment and providing better miscellaneous resources (Jevsikova et al., 2021). In such a case, unlike computer-assisted language learning, MALL delivers a new form of language learning that is more interactive, spontaneous, and continuous in diverse contexts (Çakmak, 2019). Stockwell (2016) argues that portable devices are more advantageous than desktop or laptop computers for two reasons. First, they can be carried around anytime and anywhere, enabling learners to access the needed material whenever and wherever they want. Second is the possibility of interacting with the surroundings through a global positioning system (GPS). Consequently, these devices open new learning opportunities, create a more flexible atmosphere, provide constant and fast access to information, and enhance self-learning abilities (Ihnatova et al., 2021). In

addition, they facilitate teaching students with exceptional needs and promote virtual classrooms where learners and teachers can interact in real-time (Kudratilloev & Akhmedov, 2021). Furthermore, according to Haleem et al. (2022), mobile devices cost less than PCs and can be used inside and outside the classroom.

Mobile phones are among the latest mobile devices that have piqued the attention of many instructors and researchers due to their enhanced functionality (Gangaiamaran & Pasupathi, 2017). They are no longer simply devices for chatting or organising contacts and diaries. They are now pocket devices capable of delivering learning objects and providing access to web systems and services. The number of mobile phones is three times greater than the number of PCs. In addition to this widespread ownership and use, their multiple functionalities, similar to PCs with other new features, make a mobile phone an alternative. According to Palalas and Hoven (2016), students now use mobile devices rather than desktops, corresponding to their lifestyles and ICT choices. Thus, this widespread use of mobile phones in daily life, leisure, business, and education challenges traditional learning and teaching methods (Kukulskahulme, 2020). These gadgets allow learners to engage in various language learning activities, such as reading e-books or listening to audio and audio-visual materials like podcasts. They can also share visual materials (videos or photos), make social contact, play games, and record audio and video documents (Çakir, 2016). Moreover, these tools include a variety of inbuilt software that can be used for learning, including online libraries, online forums, e-books, e-dictionaries, flash card software, and quiz software (Marek et al., 2021; Nkomo et al., 2021).

In summary, the existing accounts have reported multiple shared pedagogical potentials of MALL and PBL in English learning. Despite this, there is a general lack of research on integrating PBL and MALL in EFL speaking. Correspondingly, the present study seeks to address this research gap by empirically examining how effectively combining PBL with MALL, as an innovative model, enhances learners' speaking skills and how students perceive the implementation. The research examines the differences between three groups' speaking scores: one experimental group and two control groups. The experimental group received instruction through mobile-assisted projects. In contrast, the first control group (PBL) was taught speaking through project-based learning, and the second control group (ECRIF) received traditional teaching using the ECRIF model. Thus far, determining whether implementing mobile-assisted projects is more effective than project-based learning and traditional teaching of speaking. To achieve this, the following three questions were addressed:

1. Is implementing mobile-assisted project-based learning method more effective than project-based learning in enhancing students' overall speaking performance and sub-skills?
2. Is implementing mobile-assisted project-based learning method more effective than conventional teaching in enhancing students' overall speaking performance and sub-skills?
3. What are students' attitudes toward implementing mobile-assisted project-based learning method in EFL speaking?

Literature review

Project-based learning (PBL)

Project-based learning is a dynamic teaching method where students actively engage in and explore real-life curriculum-related issues. Holm (2011) describes project-based method as a student-centred instruction that occurs over an extended period, during which students select, plan, investigate, and produce a product, presentation, or performance that answers a real-world question or responds to an authentic challenge. During this process, teachers play the role of facilitators, guide learners, and provide scaffolding. The nature of project work leading to presenting a final artefact enables learners to enhance their autonomous learning (Hidayatulloh, 2020; Setia Dewi, 2020), collaboration (Andriyani & Anam, 2022), and motivation (Muhammad, 2020; Tra My et al., 2020). Rostom (2019), for instance, found that adopting projects in a Moroccan English class improved learners' autonomous learning and self-commitment, stimulated more understanding, and increased motivation for language learning. The study's results also showed that, unlike conventional teaching strategies, students enjoyed using technology and multimedia aids while delivering their final presentations.

Additionally, project-based learning is efficacious for improving English skills. In a quasi-experimental study, Mislana and Anggraini (2021) found that implementing projects helped the experimental group students improve their reading achievement better than those in the control group. Sultana and Musavi (2022) discovered positive outcomes in academic listening. Hakimah (2023) found that students gained significantly from using PBL principles in writing instruction as authentic tasks and hands-on experiences encouraged creativity, critical thinking, and problem-solving abilities. Pramesti et al. (2023) concluded that project-based learning effectively enhanced students' vocabulary mastery since the results of cycle two increased by 35.29% compared to cycle 1, thus increasing to 82.35% of students who got good scores.

Another reported benefit of implementing PBL is enhancing English speaking skills. Sirisrimangkorn (2021) investigated the impact of implementing project-based learning using presentations on EFL undergraduate learners' speaking skills. After the implementation, the findings revealed an improvement in students' speaking skills, and the analysis of students' interviews showed positive feedback from participants. Crespi et al. (2022) observed positive outcomes in developing learners' verbal, non-verbal, and social communication. Widiyati and Pangesti (2022) noted that PBL enhanced the oral proficiency of 29 seventh graders in Indonesia regarding fluency, grammar, pronunciation, and vocabulary. Suryani and Arganati (2023) combined project-based learning with ICT to teach speaking. Speaking tests and interview data showed that students' speaking abilities significantly increased between the first and second cycles. Students also offered favourable feedback on the use of ICT in PBL.

Mobile-assisted language learning (MALL)

Many mobile technology devices are extensively used by learners and teachers in language learning and teaching. Thus, terms referring to 'mobile' have emerged, namely mobile-assisted language learning (MALL). These terms relating to mobile technology have a role in the rebirth of Technology-enhanced language learning (TELL) as "new

methods incorporate the creative potential of the so-called social web and the mobility of small devices” (Healey, 2016, p. 12). Recent studies have proven the effectiveness of MALL in enhancing English skills. Benlaghrissi and Ouahidi (2024) combined MALL with Task-based Language Teaching (TBLT) and reported that the experimental group outperformed the control group in the overall writing performance as well as in the five targeted writing subskills: content and ideas, appropriate organisation, variety of vocabulary, accurate use of language, and accurate use of mechanics. Sudiatama et al. (2023) acknowledged that 80% of students improved their reading abilities. Hence, MALL was found to be an effective method to address reading comprehension strategies, such as inappropriate use of effective reading strategy, processing and remembering information, and limited vocabulary. Vera de la Torre et al. (2022) discovered that implementing English Listening and 6-minute apps had 95% favourable effects in enhancing students’ listening comprehension. Benlaghrissi and Ouahidi (2023) confirmed the pedagogical role of Flashcard World application in boosting Moroccan secondary school students’ vocabulary knowledge and acquisition better than traditional instruction.

Furthermore, several studies have recently been documented on MALL’s effectiveness in developing speaking skills. In China, Xu (2020) scrutinised the role of MALL in improving 61 university students’ listening and speaking skills in an EFL course. The author integrated Keke application with mobile-assisted language learning exercises. The pre- and post-study proficiency test findings revealed a significant improvement in students’ listening and speaking abilities, and participants expressed greater satisfaction with MALL implementation. Athoillah (2022) assessed students’ acceptance of mobile technology for learning using Talk English application. It was found that MALL enhanced students’ listening comprehension and oral speaking abilities and allowed learners to access the needed materials, control learning, and interact freely. Pebiana and Febria (2023) analysed the effectiveness of mobile-assisted language learning in enhancing speaking ability and motivation among secondary school students. The results showed an improvement in students’ post-tests in the following aspects: pronunciation (+ 10.14 pts), fluency (+ 6.3 pts), vocabulary (+ 6.1 pts), word order (+ 2.8 pts), and grammar (+ 4.1 pts). Furthermore, students responded enthusiastically to the implementation.

Therefore, previous research studies in PBL and MALL reached the same successful conclusions. However, technology integration in project-based learning is a major issue missing in the literature review, yet highly significant. Accordingly, investigating how technology and project-based learning enhance language skills, mainly speaking skills, would be relevant. More importantly, however, is investigating how mobile-assisted language learning as a new field within ICT with unique pedagogical affordances and project-based learning can enhance learners’ speaking performance.

Methodology

Participants

The study participants were 10th-grade Moroccan EFL public secondary school students. The researchers designed a speaking placement test based on students’ textbooks to ascertain the three groups’ homogeneity before orchestrating the intervention. Based on the test’s results, 91 students constituted the study participants who were randomly

Table 1 The study participants

Groups	Experimental	Control group 1 (PBL)	Control group 2 (ECRIF)
Gender			
Female	20 (65%)	16 (55%)	18 (18%)
Male	11 (35%)	13 (45%)	13 (42%)
Total	31 (100%)	29 (100%)	31 (100%)
Age			
14 years	2 (6%)	1 (3%)	1 (3%)
15–16 years	28 (91%)	28 (97%)	29 (94%)
17–18 years	1 (3%)	–	1 (3%)
Total	31 (100%)	29 (100%)	31 (100%)

assigned to three groups: the experimental group ($N = 31$; $F = 20$, $M = 11$), the first control group ($N = 29$; $F = 16$, $M = 13$), and the second control group ($N = 31$; $F = 18$, $M = 13$). All the students belonged to the same school and had almost the same English level. They were all studying English as a second foreign language, where they had to take the following courses: conversation, grammar, vocabulary, skills (reading, writing, listening, speaking), and paper-based projects. The participants' ages ranged from 14 to 18 years. The study participants are presented in Table 1.

Design and procedure

The current study adopted a pretest–posttest equivalent group design experiment with one independent and dependent variable. The independent variable (X_1) was the integration of MALL and PBL, defined as mobile-assisted projects. Meanwhile, the dependent variable (Y_1) was students' speaking performance.

The study was carried out for one semester in the academic year 2021–2022. It began immediately in the second semester, in the second week of February, with the pre-test, and continued to the last week of May with the post-test. Before the intervention, the researcher ensured that all the experimental group participants had mobile phones. Then, a round table discussion was held regarding the value of utilising mobile phones to improve English learning and speaking abilities.

Beginning in the third week of February, the three groups participated in the study using different instructional methods. The experimental group was taught speaking by integrating project-based language learning (PBL) approach with mobile-assisted language learning (MALL). In contrast, the first control group was taught speaking through project-based learning method (PBL), and the second control group was taught speaking conventionally using the ECRIF model (Encounter, Clarify, Remember and Internalise, and fluently use). It is worth noting that the experimental group used their mobile phones while the two control groups received instruction without using their mobile phones or any other mobile device. Table 2 summarises the treatment schedule.

The design of mobile-assisted projects focused primarily on carrying out projects using technology through students' mobile phones. This innovative model enabled students to carry out projects using their mobile phones during the project phases (pre-project stage, conducting the project, and presenting it). In the pre-project stage,

Table 2 The treatment schedule

Weeks	The experimental group	The PBL group	The ECRIF group
Week 1	Took the speaking pre-test Introduced to mobile-assisted project implementation	Introduced to project-based learning	Introduced to conventional speaking teaching methods
Two weeks	Mobile-assisted project 1: Designing a brochure	Project 1: Designing a paper-based brochure	Speaking task 1: Group discussions/Preparing an oral report
Two weeks	Mobile-assisted project 2: Creating a multimedia presentation	Project 2: Making an oral presentation	Speaking task 2: Role-paly/Making a prepared talk
Two weeks	Mobile-assisted project 3: Creating a documentary	Project 3: Preparing a report	Speaking task 3: Oral presentations/Designing a questionnaire
Two weeks	Mobile-assisted project 4: Retelling a movie/play	Project 4: Retelling a movie/play	Speaking task 4: Story completion/Acting from a script
Two weeks	Mobile-assisted project 5: Designing a poster	Project 5: Designing a paper-based poster	Speaking task 5: Picture narrating/Group discussions
Week 17	Took the speaking post-test Responded to the attitude post-questionnaire	-	-

students practiced their listening skills using English Conversation Practice application. It is a free online, offline app designed for beginners, covering topics such as food, family and friends, school, shopping, arts, health, family, Etc. While practising listening, students followed native speakers with subtitles. They also assessed their listening abilities through a multiple-choice exercise that enables checking answers and allows for immediate feedback. Choosing a conversation partner and recording the conversation was also possible for students. The conversations could be saved for self or peer assessment (See Fig. 1). The listening materials served as a leading to illicit possible project

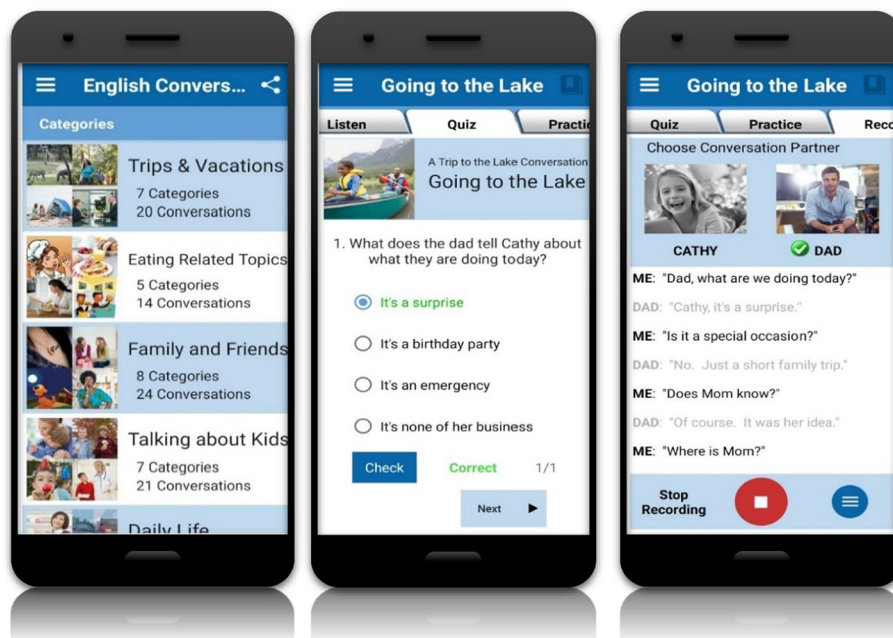


Fig. 1 Snapshots of English conversation practice app

topics. Students listened to the material for three days and discussed possible topics in the WhatsApp group through recording.

In the project cycles, students were required to use different mobile phone applications to carry out the projects, such as using WhatsApp to record audio, using a voice recorder to interview students or people outside the school, watching videos on YouTube, using Word and PowerPoint, using the camera to take pictures, making videos, creating documentaries, uploading podcasts, creating digital stories, and using other applications to design posters and brochures.

In the last phase of the project, each group presented the final product on their mobile phones by connecting them to a smart TV using the smartwatch application, as shown in Fig. 2.

During one semester of experimental treatment, mobile phone-assisted project participants were required to prepare five projects (1 for each two weeks followed by a week off). The descriptions of the projects are provided in Table 3, followed by examples of students' mobile phone-assisted projects in Figs. 3, 4, and 5. The pictures show how students used their mobile phones to carry out mobile phone-assisted projects.

Similarly, students in the first control group (PBL) were required to carry out five paper-based projects relating to the same units without using their mobile phones or any technological device. Table 4 illustrates the first project's tasks.

In each paper-based project, students had individual and group tasks. In the first project, students listened to the conversation provided by the instructor and learned new vocabulary items related to the unit's theme. In the group work, each group had to choose a topic, use paper-based forms to interview students, design the paper-based brochure, and present it. Therefore, students in the PBL group received the same project

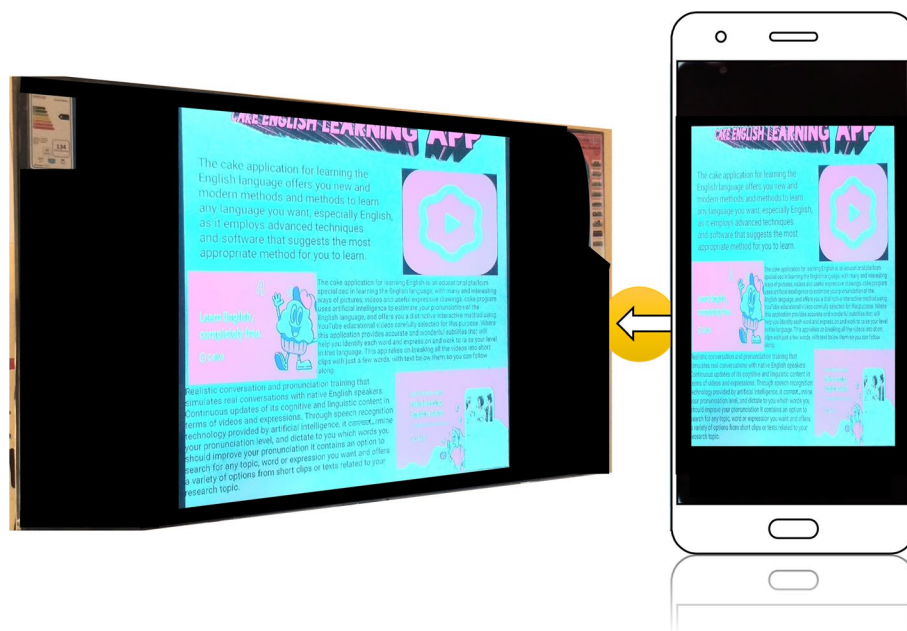


Fig. 2 Connecting mobile phones to a Smart TV

stages, learning objectives, and project tasks. However, the only difference between this group and the experimental group was the use of technology through mobile phones.

The second control group was conventionally taught the same speaking content. In each unit, two sessions were devoted to speaking. In designing the speaking lesson plans, the researcher used one of the current frameworks that support oral proficiency: the ECRIF framework developed by Kurzweil and Scholl in 2007. This student-centred framework

Table 3 Description of mobile-assisted projects

Project number	Type of project	Theme	Project description and stages
Mobile-assisted project 1	Designing a brochure	Health	Students were required to design a brochure about tips to promote students' health in a chosen area (physical, mental, social, or emotional). Students: 1. Choose a topic 2. Watched the leading video provided by the teacher 3. Used the voice recorder to interview students in school 4. Watched videos on YouTube on how to create and present a brochure 5. Used mobile phones to design the brochure 6. Shared findings with the whole class on their mobile phones
Mobile-assisted project 2	Creating a multimedia presentation	Entertainment	Students were allowed to choose an outstanding holiday destination in the area and create a multimedia presentation about it. Students: 1. Choose a destination 2. Watched the leading video provided by the teacher 3. Took pictures and videos about the destination using their mobile phones 4. Watched videos on YouTube on how to create and present a multimedia presentation 5. Used their mobile phones to create the multimedia presentation 6. Presented the multimedia presentation on mobile phones
Mobile-assisted project 3	Creating a documentary	Environment	In this project, students were expected to create a documentary about a local environmental problem in the area. Students: 1. Choose an environmental problem 2. Watched the leading documentary provided by the teacher 3. Used mobile phones to take pictures and make videos for their documentary 4. Watched videos on YouTube on how to make a documentary and present it 5. Made the documentary using mobile phones 6. Presented the documentary on their mobile phones

Table 3 (continued)

Project number	Type of project	Theme	Project description and stages
Mobile-assisted project 4	Retelling a movie/a play	Arts	Students were tasked to retell a movie or a play using the Five-Finger Retell of a Story (setting, characters, problem, events, solution/lesson). Students: 1. Choose a movie or a play 2. Watched the movie together and remembered the story 3. Watched videos on YouTube on how to retell a story and present it 4. Used their mobile phones to retell the movie in a video summary form 5. Shared the summary (in the chosen form) with the class on their mobile phones
Mobile-assisted project 5	Poster presentation	Technology	Students were supposed to demonstrate their awareness of the usefulness of modern technology. In so doing, students were given directions to design a poster about the role of modern technologies in enhancing English speaking skills. Students: 1. Choose a modern technology 2. Watched the leading video provided by the teacher 3. Searched for information about the chosen technology 4. Installed the chosen technology on their mobile phones, tried it, and learned how it works 5. Watched videos on YouTube on how to design and present a poster 6. Designed the poster using mobile phones 7. Presented the product on their mobile phones

facilitates the planning of speaking activities, from encountering new information to the fluent use stage. It also helps learners in arranging activities from teacher-controlled to spontaneous student-led activities (Caiza Aucapiña et al., 2023). A description of the first speaking lesson using the ECRIF framework is presented in Table 5.

Research instruments

Speaking test

A speaking test was used as a pre- and post-test to evaluate students' speaking scores. The researchers designed the test based on students' textbooks and graded it out of 20. It was in the form of interview questions between the teacher-researcher and students and contained a warm-up and three sections. The first focused on personal information wherein students introduced themselves, talked about their free time activities and discussed tips to keep healthy. In the second section, students were required to talk about what they did the last weekend and the last movie they watched. The last section comprised two pictures that students had to describe (See "Appendix 1"). The interviews



Fig. 3 A snapshot of a brochure done by students using their mobile phones



Fig. 4 Snapshots of two posters done by students using their mobile phones

took place in the teacher-researcher room where he usually teaches his classes. Each interview lasted 3 to 8 min, depending on each student's speaking ability. The interviews were recorded using the teacher's mobile phone voice recorder.

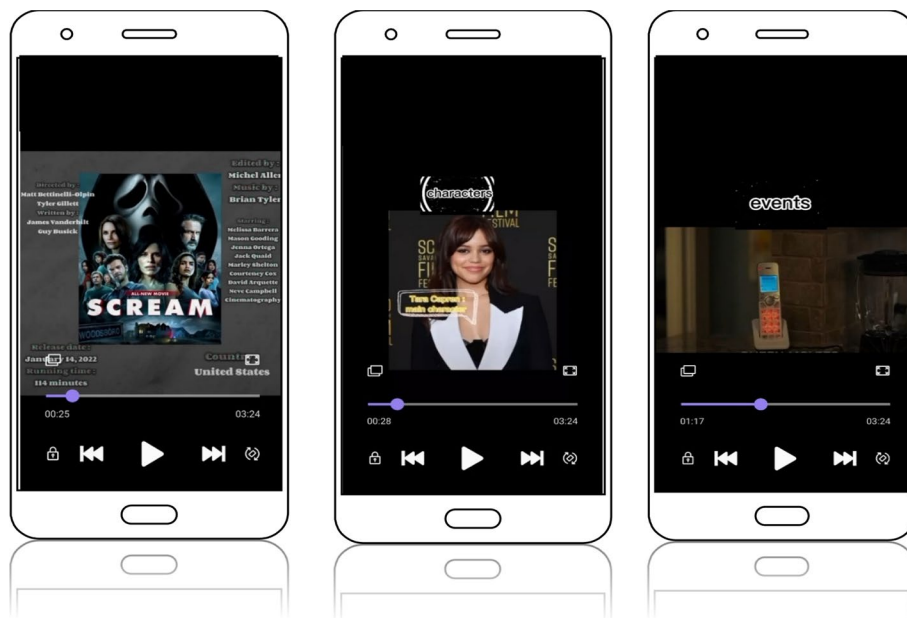


Fig. 5 Snapshots of retelling a film done by students using their mobile phones

Table 4 Tasks of paper-project 1 in the PBL group

Project number	1
Type of project	Designing a brochure
Theme	Health
Objectives of the lesson	To develop students' ability to inform and sensitise audiences about healthy habits and practices that may affect their academic performance
Project tasks	Task 1: Individual work Students listened to "Working Out and Exercising" conversation and answered the questions Vocabulary: Students learned new vocabulary related to health, such as exercising, aerobics, gym, jumping, weightlifting, pills, treatment, balanced diet, good/bad habits, Etc Task 2: Group work Students: 1. Choose a topic 2. Used paper-based forms to interview students in school 3. Designed the paper brochure 4. Presented their paper brochure

The scoring rubric was based on the International English Language Testing System (IELTS). However, the band descriptors were modified with the help of two English language supervisors to meet the target context. Then, the speaking test with modified band descriptors was given to two other English language supervisors and two experienced high school English teachers to validate it. All the experts confirmed that the scoring rubric was reliable, appropriate, and fair. The speaking test focused on fluency

Table 5 Speaking lesson 1 using the ECRIF model

Lesson 1	
Unit 6	Health
Objectives of the lesson	To develop students' ability to inform and sensitise audiences about healthy habits and practices that may affect their academic performance
Session 1	<p>1. Encounter: Students listened to "Working Out and Exercising" conversation to encounter the new information (vocabulary and structures) and participated in a short discussion based on the teacher's questions</p> <p>Vocabulary: Students learned new vocabulary related to health, such as exercising, aerobics, gym, jumping, weightlifting, pills, treatment, balanced diet, good/bad habits, Etc</p> <p>2. Clarify: Students answered the teacher's questions, compared meanings, and noticed how the newly learned information was used in context</p> <p>3. Remember and Internalise: Students answered the teacher's questions, which helped them remember, internalise, and practise the newly learned information while they observed and produced the target language</p> <p>4. Fluent Use:</p>
Session 2	<p>Task 1: In a group discussion, students discussed essential tips that could promote their health and how this might affect academic performance</p> <p>Task 2: In groups, students presented oral reports (based on answers from their peers) about tips to promote health to sensitise each other about healthy practices and habits</p>

and coherence, lexical resource, grammatical range and accuracy, and pronunciation. Each criterion was given 5 points ranging from 0 (if the student did not attend) to 5 (displayed excellent performance). To evaluate students' fluency and coherence, the focus was on students' ability to convey a basic message, produce simple speech even with repetitions and fluency problems, speak at length without noticeable efforts, speak fluently with only occasional repetitions and hesitations, and students' ability to speak fluently with rare repetitions and hesitations. About lexical resource, the primary concern was students' ability to produce isolated words to convey only personal information, discuss only familiar topics, discuss familiar and unfamiliar topics even with limited vocabulary, discuss different topics and paraphrase effectively, and use vocabulary with complete flexibility in all topics and using idiomatic language naturally. Evaluating students' grammatical range and accuracy ranged from their ability in producing basic sentence forms, producing basic sentence forms with frequent errors, producing basic sentence forms with reasonable errors, using a mix of simple and complex structures with some flexibility, to using a full range of structures naturally and appropriately. The main criteria used to assess students' pronunciation were their ability to deliver an intelligible speech, use a limited range of pronunciation features, use a range of pronunciation features, use a wide range of pronunciation features with only occasional lapses, and their ability to use a wide range of pronunciation features precisely and subtly.

For validity reasons, the speaking test was given to eight field experts: four university professors of applied linguistics, two English language supervisors, and two experienced secondary school teachers of English. The reviewers were requested to rate each part of the test from 1 to 4, with 4 being the most clear and appropriate to students' level so that the researcher could calculate Content Validity Index (CVI). At the end of the test, space was provided for the reviewers to comment or suggest revisions. Five of the eight judges reviewed and rated the test to be calculated at 0.885, thus confirming its validity (Rubio et al., 2003).

Table 6 Intraclass coefficient correlation of the pre-test and post-test

	Pre-test	Post-test
Single measures	0.839 ^a	0.823 ^a
Average measures	0.913 ^c	0.903 ^c

^a The estimator is the same, whether the interaction effect is present or not

^c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise

Two raters rated students' recordings to prove the speaking test's reliability. As illustrated in Table 6, the intraclass correlation coefficient (ICC) and Cronbach's Alpha were calculated to be 0.913 in the pre-test and 0.903 in the post-test, indicating a high level of agreement between the two raters.

Students' attitude post-questionnaire

After completing five mobile-assisted projects, students were asked to fill in a five-Likert scale survey with 16 items designed by the authors (See "Appendix 2"). The survey items were generated according to the study's objectives of probing students' experiences and attitudes toward implementing mobile-assisted projects. To serve that purpose, three dimensions were developed: students' perceived usefulness of mobile-assisted projects, students' perceived effectiveness of mobile-assisted projects in enhancing speaking skills, and students' intentions of future usage of mobile-assisted projects. The questionnaire was designed using Sphinx software and administered by the researchers at the end of the academic year using the face-to-face method. The questionnaire was designed in Arabic so students could freely and comfortably express their experiences and thoughts about the implementation. In case of ambiguity, the respondents were asked to report in their mother tongue to collect rich, in-depth, and comprehensive data.

To validate students' questionnaire, it was given to ten experts in mobile-assisted language learning and teaching. The reviewers were requested to review and evaluate the questionnaire parts regarding representativeness and clarity. Like the speaking test, the reviewers were demanded to rate each part of the questionnaire, and space was provided to comment on or suggest revisions. Eight experts responded and provided feedback; six reviewed and rated the questionnaire. The content validity test result was 0.92, suggesting that the instrument had a good level of validity (Rubio et al., 2003). Moreover, to avoid any ambiguous words in the items and guarantee their simplicity and clarity to students, three teachers of Arabic and one Arabic-English English-Arabic translation specialist reviewed the Arabic version of the questionnaire. A few modifications were made in response to their feedback.

The questionnaire was then piloted and analysed using the Cronbach Alpha Coefficient. The correlation coefficient of the total score was calculated to be 0.903. Furthermore, the correlation coefficient for the first dimension was 0.808, followed by the second dimension (0.837) and the third dimension (0.838). Thus, Cronbach's alpha was above 0.70 in the overall questionnaire and its three dimensions (see Table 7), demonstrating that the questionnaire was reliable for the study.

Table 7 Reliability statistics of students' attitude post-questionnaire

Parts of the questionnaire	Number of items	Cronbach's alpha
1. Students' perceived usefulness of mobile-assisted projects	8	0.808
2. Students' perceived effectiveness of mobile-assisted projects in enhancing speaking skills	4	0.837
3. Students' intentions of future usage of mobile-assisted projects	4	0.838
4. Total	16	0.903

Data analysis

Analysing the gathered data began with confirming a normal distribution of the speaking scores of the three groups in the pre-test and the post-test. Then, fulfilling the homogeneity was ensured. The Kolmogorov–Smirnov and Shapiro–Wilk test results established a normal data distribution of the three groups in the two tests (See Tables 8, 9). Besides, the three groups were homogeneous based on Levene's pre-test results ($p = .595$ between the experimental group and the PBL group and $p = .800$ between the experimental group and the ECRIF group). For the post-test results, the variances were also equal ($p = .230$ between the experimental group and the PBL group and $p = .578$ between the experimental group and the ECRIF group, with $\alpha > 0.05$). Therefore, parametric statistical analysis using independent sample t tests was run to compute pre- and post-test scores of the three groups to identify inter-group differences. In contrast, paired sample statistics were used for intra-group comparison, using SPSS (version 26), at the significant level of 0.05.

Table 8 Normality test of the experimental, PBL, and ECRIF groups' pre-test

Groups	Kolmogorov–Smirnova			Shapiro–Wilk		
	Statistic	df	Sig	Statistic	df	Sig
Experimental	.141	31	.120	.961	31	.309
PBL	.115	29	.200*	.957	29	.281
ECRIF	.148	31	.083	.947	31	.129

* This is the lower bound of true significance

Table 9 Normality test of the experimental, PBL, and ECRIF groups' post-test

Groups	Kolmogorov–Smirnova			Shapiro–Wilk		
	Statistic	df	Sig	Statistic	df	Sig
Experimental	.129	31	.200*	.954	31	.502
PBL	.139	29	.200*	.968	29	.502
ECRIF	.096	31	.200*	.948	31	.135

* This is the lower bound of true significance

Findings

Effect of mobile-assisted projects on students’ speaking skills

To confirm any differences in scores before treatment, two independent-sample *t* tests were carried out to compare the speaking pre-test scores between, on the one hand, the experimental group and the PBL group and between, on the other hand, the experimental group and the ECRIF group. The descriptive statistics of the three groups are displayed in Table 10.

In accordance with Table 10, the mean score for the experimental group (N = 31) was 8.68, with a standard deviation of 2.891. For the PBL group (N = 29), the mean score was 8.52, with a standard deviation of 3.007. On the other hand, the ECRIF group’s mean score (N = 31) was 8.94, and its standard deviation was 3.214. Thus, the three groups had roughly the same poor speaking proficiency. These scores, however, support what has already been manifested in the literature review that speaking skill is challenging (Brown & Yule, 1983), and EFL students encounter significant difficulties (Asratie et al., 2023; Chand, 2021). Accordingly, two independent-sample *t* tests were conducted to confirm score differences before treatment. Tables 11 and 12 present the findings:

According to the data in Table 11, a *p* value of .741, higher than 0.05, was found between the experimental and PBL groups, suggesting no statistical difference between these two groups. Furthermore, as shown in Table 12, the independent samples *t* test revealed a *p* value of .834 (2-tailed) between the experimental and the ECRIF groups, indicating no statistically significant differences between the mean scores. Overall, these results illustrate no statistical differences between the three groups in the pre-test. However, the outcome was critical for the study since

Table 10 Group statistics on pre-test of the three groups

Groups	N	Mean	Std. deviation	Std. error mean
Experimental	31	8.68	2.891	.519
PBL	29	8.52	3.007	.558
ECRIF	31	8.94	3.214	.577

Table 11 T-test on pre-test of the experimental and the PBL groups

	Levene’s test for equality of variances	t test for equality of means								
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence Interval of the Difference	
									Lower	Upper
Equal variances assumed	.285	.595	-.332	60	.741	-.258	.776	-1.811	1.295	
Equal variances not assumed			-.332	59.341	.741	-.258	.776	-1.812	1.295	

Table 12 T-test on pre-test of the experimental and the ECRIF groups

	Levene's test for equality of variances	t-test for equality of means								
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Equal variances assumed	.065	.800	-.210	58	.834	-.160	.762	-1.685	1.364	
Equal variances not assumed			-.210	57.342	.834	-.160	.763	-1.687	1.367	

it validated the premise that the three groups had the same level of language competence before initiating the treatment. In addition, the fact that the three groups had almost the same level was not surprising since a placement test was conducted to ascertain the groups' homogeneity before orchestrating the intervention.

Since the objective of the research was also to examine the impact of the treatment on students' speaking sub-skills (fluency and coherence, lexical resource, grammatical range and accuracy, and pronunciation), eight independent sample tests targeting these skills were run. The results are displayed in Tables 13 and 14:

The data in Table 13 show an equal performance between the experimental and the PBL groups in the four subskills based on the results of the pre-test as the p-value was higher than 0.05: 0.180 in fluency and coherence, 0.230 in lexical resource, 0.410 in grammatical range and accuracy, and 0.256 in pronunciation. For the experimental and the ECRIF groups, as displayed in Table 14, the four p-values were also

Table 13 T-tests on subskills of the experimental and PBL Groups

	Experimental		PBL		Sig. (2-tailed)
	Total	Mean	Total	Mean	
Fluency and coherence	70.50	2.2742	56.50	1.9483	0.180
Lexical resource	63.00	2.0323	66.50	2.2931	0.230
Grammatical range and accuracy	65.00	2.0968	65.50	2.2586	0.410
Pronunciation	70.50	2.2742	58.50	2.0172	0.256

Table 14 T-tests on subskills of the experimental and ECRIF Groups

	Experimental		ECRIF		Sig. (2-tailed)
	Total	Mean	Total	Mean	
Fluency and coherence	70.50	2.2742	71.00	2.2903	0.950
Lexical resource	63.00	2.0323	68.50	2.2097	0.376
Grammatical range and accuracy	65.00	2.0968	70.00	2.2581	0.413
Pronunciation	70.50	2.2742	67.50	2.1774	0.674

higher than 0.05 in the four subskills (0.950 in fluency and coherence, 0.376 in lexical resource, 0.413 in grammatical range and accuracy, and 0.674 in pronunciation), indicating no statistical differences in these subskills. Accordingly, the three groups had no statistical difference in the four targeted sub-skills.

After one semester of implementing mobile-assisted projects, the three groups set for the post-test to assess their performance and thus determine whether the implementation had an effect. Table 15 illustrates the mean scores of the three groups in the post-test.

According to Table 15, the experimental group’s mean score was 13.84, with a 3.976 standard deviation. The PBL group had a mean score of 11.59 and a standard deviation of 3.279. The ECRIF group, on the other hand, had a mean score of 9.58 and a standard deviation of 3.631. Thus, unlike the pre-test, the post-test outcomes revealed differences between the three groups. Two independent sample t-tests, however, were carried out to determine if the differences were statistically significant. The results are shown in Tables 16 and 17.

The data in Table 16 confirm a statistically substantial difference between the mean scores of the experimental and the PBL groups, as the p-value was higher than 0.05 ($p = .020$), with a Mean Difference of 4.385 favouring the experimental group. Similarly, Table 17 displays a significant difference (Mean Difference = 4.258) in the t-test between the mean scores of the experimental group and the ECRIF group, with a p value (2-tailed) of .000 that was less than 0.05 ($T = 4.403$; $df = 60$; $p > .05$). This illustrates that the implementation of mobile-assisted projects was more effective than project-based learning and conventional teaching.

Table 15 Group statistics on post-test of the three groups

Groups	N	Mean	Std. deviation	Std. error mean
Experimental	31	13.84	3.976	.714
PBL	29	11.59	3.279	.609
ECRIF	31	9.58	3.631	.652

Table 16 T-test on pre-test of the experimental and the PBL groups

	Levene’s test for equality of variances	t-test for equality of means								
		F	Sig	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Equal variances assumed	1.469	.230	2.385	58	.020	2.253	.944	.362	4.143	
Equal variances not assumed			2.400	57.127	.020	2.253	.938	.373	4.132	

Table 17 T-test on post-test of the experimental and the ECRIF groups

	Levene's test for equality of variances	t-test for equality of means								
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Equal variances assumed	.313	.578	4.403	60	.000	4.258	.967	2.324	6.192	
Equal variances not assumed			4.403	59.513	.000	4.258	.967	2.323	6.193	

Table 18 Shows paired samples T-tests on sub-skills of the three groups

	Experimental group			PBL group			ECRIF group		
	Pre-test	Post-test	Sig. (2-tailed)	Pre-test	Post-test	Sig. (2-tailed)	Pre-test	Post-test	Sig. (2-tailed)
Fluency and coher- ence	2.274	3.177	0.000	1.948	2.345	0.086	2.290	2.468	0.233
Lexical resource	2.032	3.468	0.000	2.293	3.397	0.000	2.210	2.323	0.269
Gram- matical range and accuracy	2.097	3.419	0.000	2.259	3.431	0.000	2.258	2.484	0.055
Pronun- ciation	2.274	3.258	0.000	2.017	2.414	0.140	2.177	2.306	0.234

About the speaking sub-skills, to determine if the post-test scores of the three groups were statistically higher than those in the pre-test, four paired sample *t* tests were applied as illustrated in Table 18:

The results of the four paired sample *t*-tests, to compare the intra-group comparison within the PBL group, showed an improvement in two sub-skills: lexical resource and grammatical range and accuracy, as the *p* value was smaller than 0.05. However, the difference was not statistically significant in fluency and coherence and pronunciation, as the *p*-values were 0.86 and 0.140, respectively. Besides, the findings indicated no statistically significant differences between the ECRIF group's pre- and post-tests in the four subskills, as the *p*-value was higher than 0.05 in the four subskills (0.233 in fluency and coherence, 0.269 in lexical resource, 0.055 in grammatical range and accuracy, and 0.234 in pronunciation). The results of the mobile-assisted projects group confirmed a significant difference between the pre-test and post-test results, as the *p*-value was smaller than 0.05 in the four subskills ($p = 0.00 < 0.05$). These findings suggest that the treatment implemented in the study intensely and positively affected students' speaking performance.

Learners' attitudes toward the implementation of mobile-assisted projects

As already noted, a post-questionnaire was administered to all the experimental group participants after they undertook the speaking post-test to probe their attitudes toward the implementation. However, the criteria displayed in Table 19 were employed to interpret the questionnaire's mean scores:

Accordingly, the analysis revealed that the overall mean score of the questionnaire was 4.4294, with a standard deviation of .38763 (see Table 20). The score, however, was very high, indicating that the study participants were highly positive about implementing mobile-assisted projects in EFL speaking courses.

For the questionnaire's three dimensions, students' attitudes toward the usefulness of mobile-assisted projects, as the first dimension, got an average mean of 4.3306 with a standard deviation of .39601 (see Table 21). All the items in this dimension had very high significance, except for item six, which was included in the high significance ($M = 4.1613$, $SD = .999$). This suggests that students had a very high positive perception toward the usefulness of mobile-assisted projects in providing various learning tools for speaking, allowing them to practise speaking anytime and anywhere, enhancing their motivation, engagement, creativity, and confidence, and making learning speaking enjoyable.

The findings further indicated that the overall mean of students' perceived effectiveness of mobile-assisted projects in enhancing speaking skills was 4.3790, with a standard deviation of .50774 (see Table 22). In this dimension, all the items were included in the very high significance level, ranging from 4.2581 (item nine), 4.3871 (items ten and twelve), and 4.4839 for item eleven.

The last dimension analysed the participants' intentions for future usage of mobile-assisted projects. Data in Table 23 revealed a level of strong agreement in all the statements, making this dimension the highest, with a mean of 4.7339 and a standard deviation of .34117. The table shows that the four items were included in the very high significance level since they all were above 4.21. These responses demonstrated that participants were comfortable, optimistic, and satisfied with the implementation and had the intention of future usage.

Table 19 The interpretation of the mean score

Mean score	Significance	Interpretation
1.00–1.80	Strongly disagree	Very low
1.81–2.59	Disagree	Low
2.60–3.40	Neutral	Moderate
3.41–4.20	Agree	High
4.21–5.00	Strongly agree	Very high

Table 20 The questionnaire overall mean

The questionnaire's overall mean	Standard deviation	Significance
4.4294	0.38763	Very high

Table 21 Students' perceived usefulness of mobile-assisted projects

Statements	Mean	SD	Sig	Total
1. Mobile-assisted projects provided me with a variety of learning tools for speaking	4.4839	0.908	Very high	31 100.0%
2. Mobile-assisted projects helped me practise speaking anytime and anywhere	4.2258	0.862	Very high	31 100.0%
3. Mobile-assisted projects boosted my motivation in speaking	4.3548	1.069	Very high	31 100.0%
4. Mobile-assisted projects helped me enhance my autonomous learning in speaking	4.3548	0.924	Very high	31 100.0%
5. Mobile-assisted projects helped enhance my engagement in speaking	4.4194	0.915	Very high	31 100.0%
6. Mobile-assisted projects helped me enhance my creativity in speaking	4.1613	0.999	High	31 100.0%
7. Mobile-assisted projects helped me enhance my confidence in practising speaking	4.3871	1.010	Very high	31 100.0%
8. Mobile-assisted projects made my speaking learning enjoyable	4.2581	0.976	Very high	31 100.0%
Weighted mean/Std. Deviation/Significance	4.3306	.39.601	Very high	

Table 22 Students' perceived effectiveness of mobile-assisted projects in enhancing speaking skills

Statements	Mean	SD	Sig	Total
9. Mobile-assisted projects helped me improve my overall speaking performance	4.2581	.77.321	Very high	31 100.0%
10. Mobile-assisted projects helped me improve my fluency in speaking	4.3871	.55.842	Very high	31 100.0%
11. Mobile-assisted projects helped me learn a variety of vocabulary items	4.4839	.50.800	Very high	31 100.0%
12. Mobile-assisted projects helped improve my pronunciation	4.3871	.66.720	Very high	31 100.0%
Weighted mean/Std. Deviation/Significance	4.3790	.50.774	Very high	

Table 23 Students' intentions of mobile-assisted projects future usage

Statements	Mean	SD	Sig	Total
13. I would like mobile-assisted projects to be integrated into English-speaking lessons	4.5161	.56.985	Very high	31 100.0%
14. I would like my teacher to continue using mobile-assisted projects in speaking lessons	4.8065	.40.161	Very high	31 100.0%
15. I would like my teacher to integrate mobile-assisted projects into other skills instead of traditional classroom learning	4.7742	.42.502	Very high	31 100.0%
16. I would like other teachers to integrate mobile-assisted projects rather than traditional classroom learning	4.8387	.37.388	Very high	31 100.0%
Weighted mean/Std. Deviation/Significance	4.7339	34.117	Very high	

Discussion

The current investigation sought to explore the impact of implementing mobile-assisted projects on EFL secondary school students' speaking performance and how students viewed the implementation. The first research query examined whether implementing mobile-assisted projects influenced learners' overall speaking ability and sub-skills. Following the research findings on the statistical analysis using independent sample t-tests and paired sample t-tests, it was found that students taught speaking through mobile-assisted projects scored significantly higher than students in the PBL and ECRIF groups. It was found that the mobile-assisted project group outperformed the PBL group ($0.020 < 0.05$) and the ECRIF group ($0.000 < 0.05$) in the post-test regarding the overall speaking performance.

Regarding the speaking subskills, while paired t-tests showed no difference between the pre-test and post-test scores of the ECRIF group in the four subskills, they showed significant differences between the PBL and the experimental groups, with varied degrees. For the PBL group, no increase in fluency and pronunciation was detected between the pre-test and post-test scores. In contrast, a significant difference was established in lexical resource and grammatical range and accuracy. The experimental group, on the other hand, displayed noticeable enhancement in the four targeted subskills: fluency and coherence, lexical resource, grammatical range and accuracy, and pronunciation. Thus far, while conventional teaching did not affect students' speaking skills, teaching speaking through project-based learning helped develop students' lexical resource and grammatical knowledge. Still, it did not improve their fluency and pronunciation. However, implementing mobile-assisted projects was the potential framework for enhancing EFL learners' overall speaking performance and subskills.

Therefore, implementing mobile-assisted projects was significantly more effective than project-based learning and traditional methods of teaching speaking in enhancing students' overall speaking proficiency as well as sub-skills. This finding corroborates the conclusions of Pebiana and Febria (2023) who demonstrated that MALL implementation improved learners' pronunciation, fluency, vocabulary, word order, and grammar. Moreover, the literature review suggests that associating MALL instruction with learner-centred approaches augments students' speaking fluency and autonomous learning (Moghaddas & Bashirnezhad, 2016).

According to Darmi and Albion (2017), practicing speaking using audio recording equipment on mobile phones improves learners' oral communication skills compared to conventional teaching. Another investigation was held at King Saud University to scrutinise the effectiveness of MALL applications in developing speaking abilities. Following the treatment, the study participants admitted that MALL apps helped them learn new words and phrases, enhanced pronunciation and grammatical knowledge, improved oral comprehension, and supported communication (Almarshadi et al., 2019). The findings of this study are also consistent with a study by Shamsi et al. (2019), which proved that MALL implementation has considerably reduced learners' anxiety while speaking English as a second language, decreased fear of speaking tests, reduced fear of feedback from peers and the teacher, and improved oral communication skills.

The findings of Azlan et al. (2019) study, which integrated task-based and mobile-assisted language learning via Instagram in EFL speaking in Malaysian primary and

pre-primary schools, are also supported by the current investigation. The results proved that most students believed that Instagram increased and inspired their eagerness to practice speaking English while enhancing their oral communication abilities. Also, integrating Instagram and task-based learning activities aligned with 21st-century learning and teaching strategies and could encourage students to improve their speaking abilities. In addition, according to Kusmaryani et al. (2019), implementing mobile applications, such as WhatsApp, YouTube, and Weebly improved the overall speaking skills of college students in Indonesia. The study results demonstrated that students made significant progress in their speaking skills regarding fluency, pronunciation and accent, vocabulary, and grammar. The results also revealed improved critical thinking ability.

The present study's findings agree with previous studies' results proving the effectiveness of mobile-assisted language learning applications and other features in improving learners' speaking skills. Studies by Soto and Zenteno (2019), Lutfi (2020), Moayeri and Khodareza (2020), and Aliakbari and Mardani (2022) revealed that students who were taught speaking through MALL instruction showed remarkable improvements in the post-test scores, compared to students who taught speaking conventionally.

The second research question concerns learners' attitudes toward implementing mobile-assisted projects. The analysis of the 5-Likerts scale survey revealed that students had a very high level of agreement toward this mode of instruction (Mean=4.4435). Besides, students were highly positive toward the usefulness of mobile-assisted projects (Mean = 4.3305). They believed that these projects provided them with various learning tools to practise speaking, helped them practise speaking anytime and anywhere, helped them enhance their motivation, autonomous learning, engagement, creativity, and confidence, and made their learning speaking enjoyable. Further, the overall mean of students' perceived effectiveness of mobile-based projects in enhancing speaking skills was 4.3790. Participants admitted that mobile-assisted projects improved their overall speaking performance, boosted their fluency, enhanced pronunciation, and helped them learn various vocabulary items.

These findings, however, are congruent with independent and paired sample *t* test findings of the experiment, showing that the implementation enhanced students' overall speaking performance and speaking sub-skills. Finally, the findings illustrated that students' intentions of future mobile-assisted project usage were the highest, with a mean of 4.7339. Students strongly agreed with integrating mobile-assisted projects as a component of English speaking. They also wished to continue using mobile-based projects and integrate them with other English skills. Moreover, they wished other teachers would implement mobile-based projects instead of conventional teaching.

The findings of the questionnaire agree with previous studies' results, which reported positive attitudes of learners toward MALL implementation. Ataeifar et al. (2019) investigated the impact of MALL instruction on 90 female students' speaking performance at the Zand Higher Education Institute. The study also sought to elicit learners' perspectives on the experiment. The analysis of the interviews revealed that most participants (71.25%) had positive perceptions of mobile learning. Based on survey questionnaires, Tonekaboni (2019) found that participants had positive attitudes toward utilising English Daily app in learning to speak and considered it valuable and convenient. In another study, Yin (2019) concluded that almost all participants

considered MALL devices effective and advantageous than conventional teaching. These tools motivated learners, provided feedback, and supported autonomous and self-directed learning.

Almadhady et al. (2021) studied the impact of MALL applications on EFL students' speaking skills in Iraq. Data was collected using reflective journals of 12 undergraduate students who used Cake-learn English application for four weeks. Based on the respondents' responses, MALL applications were fundamental to their daily learning, and most participants trusted mobile apps and preferred MALL applications to conventional teaching due to materials provided by native speakers.

The findings of the attitude post-questionnaire are also supported by Ahn and Lee (2016), Almekhlafy and Alzubi (2017), Shorna and Suchona (2019), and Soparno and Tarjana (2021). These studies demonstrated positive attitudes of learners toward MALL implementation in EFL speaking classes.

Undoubtedly, among the potential factors for the success of this mode of instruction is combining two of the most significant trends in TESOL: MALL and PBL. According to Haleem et al. (2022), mobile learning offers a variety of educational opportunities for learners unrestricted by physical location. Learners can now learn inside and outside the classroom using mobile devices, insert images, videos, and songs in their assignments, download different apps, and use them for communication and learning (McQuiggan et al., 2015). Indeed, mobile learning supports different learning styles and makes learning technology-based to support learning and enhance quality (Kukulska-Hulme et al., 2020; Zabiyeve et al., 2021). In line with these characteristics, mobile-assisted projects were applied to bridge the gap between classroom and out-of-class learning, base learning on technology by utilising mobile phones during the different stages of each project, support situated and authentic learning that occurs in meaningful situations and contexts, and tackle real-world problems and issues.

Equally important, PBL is a dynamic teaching method where students actively engage in and explore real-life curriculum-related issues. These projects integrated speaking with other skills relying on modern technologies rather than textbook-based learning. During this process, students discussed and selected topics, prepared plans, collected data based on authentic listening texts, prepared reports, and presented their final artefacts. Students in this approach, unlike conventional teaching, worked together to achieve specific learning goals. This enabled them to construct their knowledge and demonstrate their cooperative, communication, and critical skills, to name a few.

Another potential factor for the success of the implementation was designing projects based on the critical characteristics of PBL provided in the literature review. These projects focused mainly on making learning student-centred, using a driving question to tackle curriculum-related issues, encouraging the use of modern technologies through mobile phones, connecting classroom learning to real-life experiences, integrating other language skills, fostering life-long skills, and adopting peer and self-assessment tools (Andriyani & Anam, 2022; Hakimah, 2023; Suryani & Arganati, 2023). Accordingly, mobile-assisted projects were applied not only to enhance learners' speaking skills but also to help students practise speaking anytime and anywhere; to enhance their motivation, autonomous learning, engagement, and creativity; to boost their confidence while practising speaking; and to make learning speaking enjoyable.

Limitations of the study

Though the current study filled some mobile-assisted language learning and project-based learning research gaps by combining these two approaches in EFL speaking, it has some limitations. First, a limited number of participants targeted only one English skill. The research also provided a quantitative analysis of implementing mobile-assisted projects. Thus, future research should include prominent participants in diverse settings with different age groups and speaking proficiency levels. Researchers should also investigate other English skills, such as writing, to confirm the present study's findings with other skills' findings. In addition, adopting qualitative methods such as interviewing students for a more in-depth implementation analysis is highly recommended. Finally, investigating teachers' training needs regarding the use of MALL in teaching English is necessary as more and more students have access to learning materials through these modern technologies. This will help consider and develop programs of professional development aiming at supporting teachers in utilising these technologies appropriately and effectively. Addressing these issues will significantly improve English learning and teaching through modern mobile technology, ensuring that mobile-assisted language learning remains a relevant, innovative, and effective approach to English learning and teaching.

Conclusion and implications

This study explored the impact of integrating MALL and PBL, defined as mobile-assisted projects, on EFL secondary school students' speaking performance. It also probed the learners' perceptions using a 5-Likert scale questionnaire. The results of the speaking tests proved that mobile-assisted projects had an enormous impact on students' overall speaking performance and the following sub-skills: fluency and coherence, lexical resource, grammatical range and accuracy, and pronunciation. Further, the results of the attitude questionnaire displayed a very high positive perception of the learners toward the implementation. However, the effectiveness of mobile-assisted projects was supported by some potential factors, including combining two effective teaching approaches to second language learning: MALL and PBL. Moreover, designing mobile projects based on critical characteristics of PBL to shift from teacher-centred learning to more student-centred learning using technology made learning innovative, enjoyable, and more effective than conventional teaching.

Considering the favourable outcomes of the current study, pedagogical implications for EFL teachers, students, and instructional designers are provided. Instructors can integrate mobile-assisted language learning in project work to improve EFL learners' speaking skills, boost their motivation, autonomous learning, engagement, creativity, and confidence, and make learning speaking enjoyable. The implementation also has the potential to bridge classroom with out-of-class learning. Students are also encouraged to use their mobile phones in general and specifically while carrying out projects in speaking classes. This will help improve collaborative learning and creativity. It will also support learning and enhance learning productivity. Finally, curriculum designers are highly recommended to integrate cutting-edge ICT tools, mainly mobile phones, to increase learners' literacy skills and improve project quality.

Appendix 1: speaking Test

Section one:

1. Introduce yourself.
2. What type of activities do you like to do in your free time?
3. What should people do to keep healthy?

Section two:

1. What did you do during the last weekend?
2. Tell me about the last movie you watched.

Section three:

Look at the following pictures! Describe what they are about.



Picture 1:



Picture 2:

Appendix 2: students' attitude post-questionnaire

Section one: Background information

Please provide the following information by ticking (✓) in the appropriate box.

1. Gender: Female Male

2. Age: 14 years 15–16 years 17–18 years

Section two: Students' experience and attitudes toward implementing mobile-assisted projects.

We would like you to tell us how much you agree or disagree with the following statements by simply ticking (✓) a number from 1 to 5. Please do not leave out any of items.

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
1. Mobile-assisted projects provided me with a variety of learning tools for speaking					
2. Mobile-assisted projects helped me practise speaking anytime and anywhere					
3. Mobile-assisted projects boosted my motivation in speaking					
4. Mobile-assisted projects helped me enhance my autonomous learning in speaking					
5. Mobile-assisted projects helped enhance my engagement in speaking					
6. Mobile-assisted projects helped me enhance my creativity in speaking					
7. Mobile-assisted projects helped me enhance my confidence in practising speaking					
8. Mobile-assisted projects made my speaking learning enjoyable					
9. Mobile-assisted projects helped me improve my overall speaking performance					
10. Mobile-assisted projects helped me improve my fluency in speaking					
11. Mobile-assisted projects helped me learn a variety of vocabulary items					
12. Mobile-assisted projects helped improve my pronunciation					
13. I would like mobile-assisted projects to be integrated into English-speaking lessons					
14. I would like my teacher to continue using mobile-assisted projects in speaking lessons					
15. I would like my teacher to integrate mobile-assisted projects into other skills instead of traditional classroom learning					
16. I would like other teachers to integrate mobile-assisted projects rather than traditional classroom learning					

Abbreviations

ECRIF model	Encounter, clarify, remember and internalise, and fluently use
ICT	Information Communication Technologies
MALL	Mobile-assisted language learning
PBL	Project-based learning
PBLL	Project-based language learning
TELL	Technology-enhanced language learning

Author contributions

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The data collected and analysed for this research is available in SPSS format. It will be released for private use upon request.

Declarations**Competing interests**

The authors declare that they have no competing interests.

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