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Technology-enhanced Language Learning: Impacts of Duolingo Application on Micro Skills of L2 Speaking in Iranian Intermediate EFL Learners

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ABSTRACT

Objective: This study investigated the impact of the Duolingo application on the micro-skills of L2 speaking (grammar, vocabulary & pronunciation) among intermediate-level English as a Foreign Language (EFL) learners in Iran.

Methods: The participants were 60 Iranian EFL learners, aged 25-30, selected based on their proficiency in the Oxford Quick Placement Test (OQPT), and were divided into an experimental group (EG) and a control group (CG). The EG used Duolingo for language learning, while the CG received traditional face-to-face instruction. Both groups were pre-tested and post-tested using an IELTS speaking test, which assessed general speaking proficiency of the participants. A questionnaire was also administered to the EG to assess their attitudes toward the Duolingo application.

Results: The results indicated that the EG outperformed the CG on the posttests of micro speaking skills of vocabulary and grammar, but no significant difference was found between the groups for pronunciation. Furthermore, the EG reported generally favorable attitudes towards the app.

Conclusions: This study highlights the potential of technology-enhanced language learning tools like Duolingo in enhancing L2 speaking skills, suggesting avenues for further research into personalized and technology-driven language instruction.

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Introduction

To improve teaching and learning quality, using new methods can be a useful solution. One such method is Computer-Assisted Language Learning (CALL) which refers to the application of computers in learning and teaching English. As Levy (1997) stated, CALL is the study of applications of the computer in language teaching and learning process. Moreover, Davies (2002) defined CALL as an approach to language teaching and learning in which the computer is used as an aid to the presentation, reinforcement, and assessment of material to be learned, usually including a substantial interactive element. CALL can provide teachers with individualized instructions permitting students to work at their own pace (Nachoua, 2012). In addition, CALL can promote language interaction between teacher and learners (Tatiana Dina & Ciornei, 2013). CALL can help to apply experiential learning and practice in a variety of modes, provide useful feedback for students, encourage pair and group work, develop exploratory and global learning, boost student's achievement, pave the way for accessing authentic materials, facilitate better interaction, individualize instruction, and motivate students (Hashemifardnia et al., Lee, 2000).

CALL has different kinds of modes; one of which is Duolingo that is a mobile and web-based application designed for learning foreign languages. It offers two versions: one for students and another for teachers. For students, Duolingo provides a variety of exercises and quizzes focused on grammar and vocabulary, organized by proficiency level (Yuwono, 2022). For teachers, the app offers tools for student management, curriculum planning, assignment preparation, class activity monitoring, and the ability to provide tests, feedback, and assessments, which are highly beneficial for instructional purposes (Zamzami, 2019). The application is suitable for learners at all levels, from beginners to advanced users, and can be used by people of all ages, from young children to older adults.

The Duolingo app features various exercises that aid in vocabulary expansion, including listening, reading, and vocabulary practice. Additionally, it provides tools for tracking user progress and delivering feedback to enhance language skills. According to Ajisoko (2020), learners can use apps like Duolingo to engage with English in a playful and interactive manner. Developed by Luis Von Ahn and Severin Hacker in 2012, Duolingo is a free platform that offers a fun, non-boring way to learn languages. The app includes various features to accelerate language learning, such as daily word list creation, social interaction with other users, and opportunities for advanced learners

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to earn experience points. These features underscore Duolingo's appeal as an engaging and effective language-learning tool, promoting English proficiency through enjoyable, interactive exercises.

Several studies have highlighted Duolingo's effectiveness as a technology-based tool for teaching English. Yuwono (2022) examined Duolingo's effectiveness in teaching vocabulary and found a significant improvement in student scores following the use of the app. Similar research by Aisyah and Hidayatullah (2020) and Hardiyanti et al. (2021) also demonstrated Duolingo's positive impact on vocabulary acquisition. Herlina et al. (2021) investigated Duolingo's use in enhancing speaking skills among senior high school students. Their findings showed consistent improvements in students' speaking scores across cycles, as well as increased self-confidence and motivation to speak English. Niah and Pahmi (2019) also reported that Duolingo improved both speaking and listening skills among junior high school students, according to the ASSURE model.

Alfuhaid (2021) conducted a study on Duolingo's effectiveness in EFL classrooms to enhance students' speaking abilities. The research involved 28 male Saudi students, who were divided into experimental and control groups. After four months of using Duolingo, the experimental group showed a significant improvement in speaking proficiency compared to the control group, which had not used the app. The findings highlighted Duolingo's beneficial effect on speaking competence and overall language skills.

Fitria et al. (2023) explored students' perceptions of using Duolingo to improve their speaking skills and identified areas of improvement. The study, conducted with 20 senior high school students from Banda Aceh, revealed that 90% of participants felt that Duolingo improved their English speaking abilities. Among the improvements, vocabulary stood out as the most enhanced aspect, followed by pronunciation, grammar, and fluency.

Li and Bonk (2023) examined self-directed language learning (SDLL) experiences, benefits, and challenges among Duolingo users in non-classroom settings. Through in-depth interviews with 10 learners, the study found that learners used Duolingo to track and reinforce their progress. Motivated primarily by intrinsic factors like cultural exploration and travel, most users engaged with the app to further their language skills, rather than for external rewards like certificates or grades. Similarly, Vinni and Sitti (2023) investigated Duolingo's impact on 10th-grade students' motivation and vocabulary growth at SMKN 1 Padang. Their findings indicated that Duolingo

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significantly boosted students' motivation to study English and contributed to enhanced vocabulary acquisition.

Dearestiani (2023) conducted research to assess how Duolingo could improve students' speaking skills. The study, which involved 31 eighth-grade students at SMP Negeri 35 Samarinda, showed that Duolingo had a positive effect on students' speaking fluency. The students became more enthusiastic and engaged in English language learning, with their speaking skills improving through the use of the app. Finally, Budiyanto and Ridho (2024) examined Duolingo's effectiveness in improving speaking abilities among eighth-grade students at SMPN 46 Palembang. Their research, using a quasi-experimental design, found that the Duolingo group showed significant improvement in speaking proficiency compared to the control group. The dependent sample t-test confirmed improvements in speaking skills, while the independent sample t-test demonstrated that the Duolingo group outperformed the control group.

Research Gap and Questions

Previous research has highlighted Duolingo's effectiveness in improving general language skills, particularly vocabulary and speaking. However, there is a gap in studies that examine its impact on the micro-skills of speaking, such as fluency, pronunciation, grammar, and discourse management, especially among intermediate-level English as a Foreign Language (EFL) learners in Iran. Existing studies have often focused on overall speaking proficiency or vocabulary improvement (Yuwono, 2022; Aisyah & Hidayatullah, 2020; Hardiyanti et al., 2021), with limited attention to the specific aspects of speaking that contribute to effective communication. Additionally, while some studies have explored Duolingo's effects on speaking in various EFL contexts (Herlina et al., 2021; Alfuhaid, 2021), they have not addressed the unique cultural and educational dynamics of Iranian learners. Furthermore, there is little research on how Duolingo's features, such as speech recognition and interactive exercises, affect the development of speaking micro-skills. The current study seeks to fill this gap by exploring Duolingo's impact on the specific micro-skills of L2 speaking—pronunciation, grammatical accuracy, and vocabulary—among Iranian intermediate EFL learners. Therefore, two questions were addressed:

1. What is the impact of using the Duolingo application on the micro-skills of L2 speaking (pronunciation, grammatical accuracy, and vocabulary) among Iranian intermediate EFL learners?

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2. What are the attitudes of Iranian intermediate EFL learners towards using the Duolingo application for improving their general English learning?

Material and Methods

Participants

After deciding on the purpose of the study and research question, the next step was to determine *who* would provide the best information to help answer the research questions. The population of this study included intermediate EFL learners in Shahreza, Isfahan, Iran. This study was conducted with the participation of 150 Iranian EFL learners. The researcher accessed and selected the available EFL learners in several private language institutes in Shahreza, who volunteered to take part in the study. They were chosen from among homogeneous (in terms of language proficiency) EFL learners, whose proficiency levels had been assessed through the administration of an Oxford Quick Placement Test (OQPT). The participants were native speakers of Persians and included both female and male language learners. Their exposure to English language in language institutes ranged from 2 to 5 years, and they were aged between 25 and 30. The subjects were randomly divided into two similar groups, one of which was considered as the EG and the other as the CG. The EG was taught through Duolingo application, and the CG was taught through traditional instruction.

Data Collection Instruments

The first instrument which was used in the current study was the OQPT. It was administered to help the researcher select the homogenous participants. According to this test, the learners who scored between one standard deviation (SD) above and one SD below the mean were determined as the intermediate and were considered as the target population of the study. This test consisted of 60 items which were developed by Oxford University Press and the University of Cambridge Local Examinations Syndicate. The test has been validated in 20 countries by more than 6,000 students and its reliability has reached 0.90 (Geranpayeh, 2003). This test has 60 multiple-choice items and based on it the learners whose scores are 0 to 10 are beginners; the learners whose scores are 11 to 17 are considered as breakthrough; the learners whose scores are 18 to 29 are elementary; those learners whose scores are 30 to 39 are pre-intermediate; the students whose scores are 40 to 47 are intermediate; the learners whose scores are 48 to 54 are considered as the advanced learners

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and those whose scores are 55 to 60 are very advanced learners. The OQPT assesses reading comprehension (in the form of a cloze test) and vocabulary and grammar knowledge.

A sample of IELTS speaking test was containing 3 parts that each part lasted about 3 minutes. This test was used as the speaking pretest of this study. In the first part of the test, test takers answered general questions about themselves and a range of familiar topics, such as their home, family, work, studies and interests (4-5 minutes). In the second part, test takers were given a card which asked them to talk about a particular topic. They had one minute to prepare before speaking up to two minutes. The examiner might then ask one or two questions on the same topic to finish this part of the test (3-4 minutes). In the third and last part, test takers were asked further questions connected to the topic in Part 2. These questions gave the test taker an opportunity to discuss more abstract issues and ideas (4-5 minutes). This pretest exam cleared out that whether the individuals were in the same speaking level or not. Here, the EG worked with Duolingo application while the CG received common traditional face to face classes in which speaking skills were practiced. In the end, a speaking posttest was taken like the pretest. The pretest and the posttest were scored by two raters and inter-rater reliability was calculated through Pearson correlation. The reliability index for the pretest was .86 and for the posttest it was .79.

Another instrument used in this study was a questionnaire given to participants in the EG to assess their overall attitudes toward using the Duolingo platform. The questionnaire, developed by the researchers of this study, was based on a review of literature related to Duolingo. It included 15 items addressing participants' attitudes toward using Duolingo, and responses were measured on a Likert scale ranging from 1 to 5, where options included: strongly disagree, disagree, neutral, agree, and strongly agree. The questionnaire's reliability was confirmed with a Cronbach’s alpha of .83. Additionally, the instruments, including both the pre- and post-tests and the questionnaire, were piloted with a different group of students who shared similar characteristics (language proficiency, age, and gender) with the target group to ensure the tools’ feasibility for the main study.

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Procedure

The data collection procedure consisted of four main phases:

Participant Selection and Group Assignment

From an initial pool of 150 EFL learners, 60 participants were selected based on their similar language proficiency levels, as assessed by the Oxford Quick Placement Test. These 60 participants were then randomly divided into two groups of 30 each: the EG and the CG. The EG was designated to receive instruction via the Duolingo app, while the CG was to receive traditional classroom-based instruction. This initial grouping ensured a balanced comparison of instructional methods.

Pretesting

To assess initial speaking proficiency levels, an IELTS speaking test was administered to all participants as a pretest. This test, structured in three parts lasting around 3 minutes each, included general questions on familiar topics, a short prepared response, and a discussion on abstract ideas.

Treatment

In the CG class, the teacher's role was more dominant than the student's role and it was teacher-centered. The students got the facts and skills through obtaining the material given by the teacher and media resources and the teacher controlled and managed the classroom. The traditional classroom was deprived of technology and students were taught in the classroom. Before teaching each conversation, the teacher provided the students with information about the main topic and then played the audio file of the conversation. The students repeated the audio file and after teaching each conversation, the students practiced the conversation with their partners and performed it in front of the class. The teacher gave the students feedback and corrected the students' mistakes. This method continued until the last session.

While the CG underwent a conventional class where the students were required to speak on different topics and were provided with feedback on the content, structure, and organization of what they spoke, the EG was exposed to Duolingo application during the class. Pictures were displayed on a screen and students had to say the word of each picture aloud. In some of the sections, learners listened and repeated what they heard, watched movies or videos on their own and repeated what they saw or heard, said the opposite of words , answered short questions, and retold stories in their own words and did their speaking exercises. The teacher prepared a list of topics

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that students were able to talk about and then divided the class into two teams, and student chose a number - that's the order they went in. Each student responded to a statement without preparation. They had to continue speaking for 45 seconds. As the student was speaking, the other team listened for moments of hesitation, grammatical mistakes, and vocabulary mistakes. If the other team could not correctly identify an error, they got a point.

The speaking part of the Duolingo which the EG worked with consisted of 5 parts.

Saying the English word for each image. In this part of Duolingo speaking, pictures were displayed and students had to say the word of each picture aloud. Usually pictures were names like cat, fish, tiger, etc.

Reading aloud. The students read a sentence aloud .The moderator recorded and sent their voice by saying the sentence that was displayed.

Giving verbal answers to a spoken question. In this section, questions were asked orally and in addition to understanding it, the students had to also give the appropriate answer. In fact, both listening and speaking were evaluated.

Replying to question card. In this section the students had to talk about a topic. This section was similar to IELTS cue cards.

Describing a photo orally. In this part, the students had to talk about an image for at least 30 seconds and at most one and a half minutes.

Post-testing and Questionnaire Administration

Upon completing the treatment, both groups were given a speaking posttest similar to the pretest to measure the effects of the instruction. Additionally, participants in the EG completed a 15-item questionnaire developed to gauge their attitudes toward the Duolingo platform.

Data Analysis

To analyze the data, one-way MANCOVA test was used to compare the scores of the pretests and posttests of the EG and CG. In addition, one samples t-test was used to analyze the data collected by attitude questionnaire.

Results

First, the Kolmogorov-Smirnov test was used to check the normality distribution of the data and the results showed that the distribution of the data was normal as the *Sig.* values were higher than

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0.05. Therefore, the parametric statistics such as one-way MANCOVA was run to provide an answer for the first and the second research questions.

Effect of Duolingo on Speaking Micro-skills

In Tables 1 and 4, the results related to the effectiveness of Duolingo on Iranian EFL learners' speaking micro-skills are presented.

Table 1. One-Sample Kolmogorov-Smirnov Test (Post-tests of Speaking Micro-skills)

Variable		Vocabulary Control posttest	Grammar Control Posttest	Pronunciation Control posttest	Vocabulary Experimental posttest	Grammar Experimental posttest	Pronunciation Experimental posttest
N		30	30	30	30	30	30
Normal Parameters[a,b]	Mean	13.5667	13.3667	15.1333	16.2000	15.7000	16.3333
	Std. Deviation	.62606	1.86591	.77608	1.37465	.53498	1.93575
Most Extreme Differences	Absolute	.317	.379	.235	.425	.245	.368
	Positive	.317	.254	.202	.425	.245	.368
	Negative	-.256	-.379	-.235	-.209	-.232	-.212
Test Statistic		.317	.379	.235	.425	.245	.368
Asymp. Sig. (2-tailed)		.072	.602	.192	.321	.511	.097

a. Test distribution is Normal, b. Calculated from data, c. Lilliefors Significance Correction

Based on the results presented in Table 1, all *Sig.* values are greater than 0.05. Therefore, we can say that the distribution of the data was normal in the posttests of micro-skills. Consequently, we used the parametric statistics like one-way MANCOVA to answer research question addressing the effectiveness of Duolingo on Iranian EFL learners' speaking micro-skills.

Table 2. Descriptive Statistics of Both Groups on the Speaking Micro-skills Posttests

Variable	Groups	Mean	Std. Deviation	N
Vocabulary	EG	16.2000	1.37465	30
	CG	13.5667	.62606	30
	Total	14.8833	1.69837	60
Grammar	EG	15.7000	.53498	30
	CG	13.3667	1.86591	30
	Total	14.5333	1.79893	60
Pronunciation	EG	16.3333	1.93575	30
	CG	15.1333	.77608	30
	Total	15.7333	1.58239	60

The mean scores of the CG are 13.56, 13.36, and 15.13 on the vocabulary, grammar, and pronunciation post-tests, respectively. This table also shows that the mean score of the vocabulary

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posttest of the EG is 16.20. The EG's mean score on the grammar posttest is 15.70 and their mean score on the pronunciation posttest is 16.33. It appears that the EG obtained better scores than the CG on the vocabulary and pronunciation posttests. To ensure that the differences between the micro posttests of both experimental and control groups were noticeable, a one-way MANCOVA was utilized and the results are shown in Table 3:

Table 3. Inferential Statistics of Both Groups on the Speaking Micro-skills Posttests

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Groups	Pillai's Trace	.807	73.825[b]	3.000	53.000	.000	.807
	Wilks' Lambda	.193	73.825[b]	3.000	53.000	.000	.807
	Hotelling's Trace	4.179	73.825[b]	3.000	53.000	.000	.807
	Roy's Largest Root	4.179	73.825[b]	3.000	53.000	.000	.807

a. Design: Intercept + Vocabulary Pre + Grammar Pre + Pronunciation Pre + Groups, b. Exact statistic

The multivariate test results indicate several important findings. For the factor labeled Groups (likely representing two or more instructional or experimental conditions), the p-value is .000 across all four multivariate tests (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root), which is well below the significance threshold of .05. This suggests that there is a statistically significant difference between the groups on the combined dependent variables (speaking micro-skills: vocabulary, grammar, and pronunciation). The Partial Eta Squared value for Groups (.807) is high, indicating a large effect size, meaning that the group differences explain a substantial portion of the variance in speaking micro-skills.

Table 4. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Groups	Vocabulary	76.413	1	76.413	101.873	.000	.649
	Grammar	60.371	1	60.371	35.940	.000	.395
	Pronunciation	3.443	1	3.443	2.212	.143	.039

The results in Table 4 highlight significant differences in vocabulary and grammar scores between the two groups, while pronunciation scores did not show significant differences.

Vocabulary: The Group effect for vocabulary has a significance (Sig) value of .000, which is below the .05 threshold. This indicates that the vocabulary scores differ significantly between the two groups, with a high Partial Eta Squared of .649, suggesting that group membership explains about 65% of the variance in vocabulary scores. This substantial effect size indicates that the

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intervention or condition applied to the EG likely contributed to higher vocabulary posttest scores compared to the CG.

Grammar: Similarly, for grammar, the Group effect also has a Sig value of .000, showing a statistically significant difference between the two groups on grammar scores. The Partial Eta Squared of .395 suggests that about 40% of the variance in grammar scores is explained by group differences, meaning the EG likely scored higher than the CG on the grammar posttest.

Pronunciation: In contrast, the Group effect for pronunciation has a Sig value of .143, which is above .05. This indicates that there is no statistically significant difference between the two groups in pronunciation scores. The Partial Eta Squared for pronunciation (.039) is also low, indicating that group membership accounts for only a small portion of the variance in pronunciation scores.

In summary, the EG outperformed the CG in vocabulary and grammar posttests, but no significant difference was found between the groups for pronunciation. This suggests that the intervention primarily influenced vocabulary and grammar skills rather than pronunciation.

Attitudes towards the Effects of Duolingo on Speaking Micro-skills

In this part, the other research question related to attitudes towards the effects of Duolingo on speaking micro-skills was answered. To do so, one sample *t*-test was used to analyze the data gathered through administering the related questionnaire. Taking a look at the mean scores of the questionnaire items in Table 5, it could be seen that all mean scores are higher than 3.00. This would indicate that the participants showed positive attitudes toward using Duolingo application. All items in the above questionnaire received mean scores above 3.00, which means that the participants concurred with all statements in the questionnaire. On the whole, as it went above, the participants tended to agree with the majority of the questionnaire items.

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Table 5. Results for the Speaking Micro- skill Attitude Questionnaire

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
1. Duolingo improves the students' vocabulary knowledge.	0	0	0	10	20	4.6	.47
2. We learn grammar better by using Duolingo.	1	0	1	0	28	4.8	.80
3. Using this method enhances our pronunciation.	2	1	3	10	14	4.1	1.15
4. Duolingo has more variety for the students.	0	3	0	6	21	4.5	.93
5. This method of teaching is interesting.	2	2	0	13	13	4.1	1.15
6. This method of teaching motivates me to succeed.	1	1	2	7	19	4.4	1.00
7. This application makes pronunciation learning easier.	0	0	0	15	15	4.5	.50
8. Students can learn grammar and vocabulary more easily by using this application.	0	0	3	5	22	4.6	.66
9. I suggest other students to use this application to learn English.	1	1	0	10	18	4.4	.93
10. I prefer Duolingo learning to traditional learning.	2	2	0	4	22	4.4	1.22
11. Learning by Duolingo can takes place everywhere.	0	1	0	0	29	4.9	.54
12. Learning by Duolingo is more student-centered.	1	1	0	4	24	4.6	1.04
13. We are free to decide when we spend our time with this application.	4	2	3	0	21	4.06	1.52
14. I can learn whenever I want.	1	0	2	0	27	4.7	.86
15. This application can be useful for teaching the main skills.	0	1	0	2	7	4.8	.59

Table 6. Descriptive Statistics of the Students' Speaking Micro-skills Questionnaire

Variable	N	Mean	Std. Deviation	Std. Error Mean
Speaking Micro-skills	15	4.4973	.26097	.06738

In the table 6, the descriptive statistics of 15 items related to the attitudes of the students towards the effects of Duolingo on speaking micro-skills are shown. Based on the results, the mean is 4.49 and the standard deviation is .26. To see if the extent to which the participants had positive attitudes toward instruction via Duolingo was of statistical significance or not, a one-sample *t*-test was employed in the following table:

Table 7. One-Sample Test of the Students' Speaking Micro-skills Questionnaire

Test Value = 0					
T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
66.743	14	.000	4.49733	4.3528	4.6419

As revealed in Table 7, the amount of statistic *T*-value is 66.74 (*t*=66.74), *df*=14 (*df*=14) and the significance level is 0.000 (*sig*=0.000) which is less than 0.05. This indicates that Iranian EFL

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learners had positive attitudes towards the application of Duolingo. The *p* value under the *Sig*. (2-tailed) column is less than the .05 level of significance; meaning that the difference between the overall mean score of the questionnaire items and the average value of the choices was of statistical significance.

Discussion

The results of this study align with findings from numerous previous studies that support the effectiveness of Duolingo as a tool for developing English language skills. The present results show that the EG, which received instruction through Duolingo, outperformed the CG on posttests measuring speaking micro-skills, specifically vocabulary and grammar. However, no significant difference was found between the groups regarding pronunciation, indicating that Duolingo's impact may be more pronounced in vocabulary and grammar acquisition than in pronunciation skills. The results also indicated that participants had positive attitudes toward instruction via Duolingo in Iranian EFL context.

These findings are consistent with Yuwono (2022), who found that Duolingo significantly improved vocabulary scores among students using the platform for language learning. Similarly, Aisyah and Hidayatullah (2020) and Hardiyanti et al. (2021) also concluded that Duolingo significantly enhanced vocabulary acquisition, which reinforces the idea that Duolingo is particularly effective in supporting vocabulary growth. Additionally, Fitria et al. (2023) reported that vocabulary was the area of speaking skills that saw the most improvement through Duolingo, with pronunciation and grammar skills also showing notable gains, further aligning with the present study's findings.

Also, these findings are in line with studies by Niah and Pahmi (2019) and Alfuhaid (2021), who observed that Duolingo use led to increased speaking skills and overall language abilities. In particular, Alfuhaid's (2021) study on Saudi EFL learners found that the EG using Duolingo outperformed the CG, much like the current study's results, supporting the platform's effectiveness in enhancing speaking skills. In addition, studies exploring Duolingo's motivational effects, such as those by Vinni and Sitti (2023), have found that the platform significantly enhances students' motivation and vocabulary acquisition. Li and Bonk (2023) provided further insights into how Duolingo fosters self-directed learning by enabling students to manage and self-monitor their

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progress. The findings in the present study correspond with these motivations, as the use of Duolingo likely facilitated autonomous learning, especially in vocabulary and grammar, where improvements were observed.

Dearestiani (2023) and Budiyanto and Ridho (2024) also support the findings of this study, as both studies observed significant improvements in speaking proficiency following Duolingo use. Budiyanto and Ridho (2024) found that the EG using Duolingo outperformed the CG, mirroring the results observed here. Additionally, Dearestiani (2023) noted increased enthusiasm and engagement among students using Duolingo, suggesting that the app's interactive format promotes an active learning environment, which could explain the observed gains in vocabulary and grammar.

Some theories offers insight into why Duolingo's technology-based, interactive, and gamified approach has successfully enhanced vocabulary and grammar acquisition in the EG:

1. Sociocultural Theory (Vygotsky, 1978)

Vygotsky's Sociocultural Theory suggests that language learning is enhanced through social interaction and mediated tools. Duolingo functions as a "mediating tool" that provides a structured environment with scaffolded learning activities and feedback, which simulate interactive aspects of language use. This aligns with the finding that Duolingo helped learners in the EG improve in vocabulary and grammar, as the platform's design allows learners to practice language at their own pace while receiving immediate feedback, thereby promoting gradual linguistic development. The app also encourages learners to build on existing knowledge through leveled tasks, reinforcing new language structures within a socialized digital environment.

2. Input Hypothesis (Krashen, 1982)

Krashen's Input Hypothesis underscores the need for comprehensible input that is slightly beyond the learner's current ability, known as "i+1". Duolingo's structured lessons are designed with graded vocabulary and grammar exercises that increase in difficulty, which allows learners to receive input that is consistently challenging yet accessible. This incremental approach aligns well with Krashen's theory and explains why the EG saw improvements in vocabulary and grammar: Duolingo provides input that learners can understand and build upon, fostering acquisition through consistent exposure to language that is just beyond their current proficiency level.

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3. Cognitive Theory of Multimedia Learning (Mayer, 2001)

Mayer's Cognitive Theory of Multimedia Learning suggests that integrating visual and auditory content helps learners better process and retain information. Duolingo's multimodal approach leverages visual cues, audio elements, and interactive feedback, creating an enriched environment that supports vocabulary and grammar acquisition. The app's design aligns with Mayer's theory by helping learners engage with and internalize new language concepts more effectively, likely contributing to the EG's improved performance. By combining audio with visuals and interactive responses, Duolingo aids memory retention and supports language acquisition through diverse sensory inputs.

4. Self-Determination Theory (Deci & Ryan, 1985)

Self-Determination Theory emphasizes intrinsic motivation, autonomy, and competence as key drivers in learning. Duolingo's gamified format, which includes points, levels, and self-paced learning, aligns with this theory by enhancing motivation and allowing learners to take charge of their learning journey. This sense of autonomy and achievement likely contributed to the EG's better vocabulary and grammar scores, as motivated learners are more engaged and consistent in their practice. Duolingo's rewards and feedback mechanisms foster a supportive and motivating environment, sustaining learner interest and drive, which are essential for effective language learning.

5. Interaction Hypothesis (Long, 1996)

The Interaction Hypothesis posits that language development occurs through interaction and negotiation of meaning. Although Duolingo doesn't provide real-time interactions, its exercises simulate language negotiation by prompting responses, providing feedback, and allowing learners to self-correct. This interactive quality aligns with Long's theory, as learners engage with vocabulary and grammar in context and receive feedback, supporting the language acquisition process. The gains observed in vocabulary and grammar align with this hypothesis, as Duolingo enables learners to practice and refine their understanding through simulated language tasks that encourage active involvement.

6. Gamification in Language Learning (Gee, 2003)

Gee's work on gamification suggests that game-like features—such as rewards, levels, and feedback—enhance engagement and motivation, which are essential for sustained learning.

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Duolingo's gamified structure helps learners stay engaged and motivated, as they progress through levels and receive points and badges. This motivational boost supports Gee's principles and aligns with the study's findings, as the EG likely benefited from the app's game-like aspects that foster regular practice, focus, and persistence. The gamified elements thus make language learning enjoyable and rewarding, promoting deeper engagement with vocabulary and grammar tasks.

The results from this study can be attributed to several factors rooted in Duolingo's design, user engagement features, and the nature of language acquisition in an EFL context.

1. **Interactive Vocabulary and Grammar Instruction**: Duolingo's strength lies in its structured approach to vocabulary and grammar acquisition, often presenting these in small, manageable segments with frequent repetition. By continuously reinforcing vocabulary and grammar rules through varied exercises, Duolingo enables learners to internalize these language components effectively. This interactive, bite-sized format aligns well with cognitive theories of language acquisition, which suggest that repeated, meaningful exposure to language structures enhances retention and retrieval.

2. **Gamification and Engagement**: Duolingo uses gamified elements, such as rewards and progress tracking, to maintain learners' motivation. This engagement helps learners practice more consistently, which can be particularly advantageous for vocabulary and grammar development. Motivation, a key factor in language learning, often drives students to spend more time on the platform, which translates into increased exposure and practice, especially in areas like vocabulary and grammar where such repetition directly benefits language acquisition.

3. **Explicit Grammar Practice**: Unlike some language apps that focus heavily on conversational practice, Duolingo emphasizes explicit grammar rules, which can help learners develop a more robust understanding of grammatical structures. This aligns well with the structured learning needs in an EFL setting where explicit grammar instruction is often more effective due to the limited natural language exposure outside of class.

4. **Limitations in Pronunciation Training**: While Duolingo offers listening and speaking exercises, its pronunciation feedback is less sophisticated compared to vocabulary and grammar practice. The platform lacks in-depth pronunciation assessment tools that can provide nuanced feedback on intonation, stress, and specific sounds—elements essential to developing accurate

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pronunciation. This limitation likely explains why the EG did not show a significant advantage in pronunciation over the CG.

5. **Cultural and Contextual Suitability**: The positive attitudes observed among participants toward Duolingo likely stem from the app's user-friendly interface and flexibility, which align well with the needs of Iranian EFL learners. The opportunity for self-paced learning also complements traditional classroom instruction, allowing learners to practice outside of structured school hours, which may enhance their perception of Duolingo as a beneficial, supplementary tool.

Conclusion and Implication

The findings of this study contribute to the growing body of research highlighting the potential of Duolingo as an effective tool for enhancing English language skills among EFL learners. Consistent with previous studies, the EG that used Duolingo outperformed the CG in areas such as vocabulary and grammar acquisition. While no significant differences were found between the groups in terms of pronunciation improvement, the positive results in vocabulary and grammar suggest that Duolingo can be an effective supplementary tool for developing these micro-skills. Furthermore, learners in the EG expressed positive attitudes towards using Duolingo for language learning, indicating an overall favorable perception of its effectiveness in the Iranian EFL context.

This study has some implications for EFL learners, teachers, and material developers.

For EFL Learners: This study underscores the value of incorporating technology into language learning, particularly in the development of vocabulary and grammar skills. EFL learners can benefit from Duolingo's interactive and gamified approach, which may enhance motivation and engagement while providing personalized feedback. However, learners may need to complement their use of Duolingo with other methods or tools to address aspects of language learning such as pronunciation, which was not significantly improved in this study.

For EFL Teachers: EFL teachers can integrate Duolingo as a supplementary resource in their teaching strategies, particularly for vocabulary and grammar instruction. The positive attitudes towards Duolingo among learners suggest that teachers can use it to enhance learner engagement and motivation. Teachers might also consider using Duolingo alongside traditional methods to address a broader range of language skills, especially pronunciation. Continuous monitoring and guidance can help ensure that learners make the most of the tool while addressing any potential gaps in their language proficiency.

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For Material Developers: The findings of this study suggest that material developers should consider incorporating Duolingo or similar language learning apps into their instructional materials. Specifically, vocabulary and grammar exercises that are aligned with the Duolingo platform could be developed for use in classrooms. However, developers should also look into ways to integrate activities focused on pronunciation to create more well-rounded language learning experiences. Additionally, the positive learner feedback indicates a potential for future material that blends traditional teaching methods with interactive, tech-based tools like Duolingo to foster greater learner autonomy and engagement.

Limitations and Suggestions

The limitations of this study highlight several factors that may have influenced the results and suggest areas for future research to address these issues.

One key limitation concerns the sample size and its impact on generalizability. Although 150 participants were initially selected, only 60 intermediate-level EFL learners ultimately participated in the final analysis. This smaller sample size may reduce the ability to generalize the findings to a larger population, particularly those outside of Shahreza, Isfahan, or to learners with different proficiency levels. The restricted demographic also affects the applicability of the results to broader contexts, as the participants' characteristics were relatively homogenous. Another limitation relates to participant demographics. The participants in this study were all aged between 25 and 30 years and were native Persian speakers. This lack of diversity in age and linguistic background restricts the findings' relevance to other age groups or speakers of languages with different linguistic structures. Furthermore, the study did not consider the participants' prior exposure to technology or their personal preferences for learning methods. These factors could have influenced their attitudes toward the Duolingo app, which may limit the study's ability to capture a full range of experiences with the app. The duration and intensity of the intervention also warrant consideration. While the length of the intervention was not specified in detail, it may not have been long enough to observe significant changes in speaking proficiency, especially given the variability in individual learners' backgrounds and learning speeds. A longer intervention period might have yielded more conclusive results, providing stronger evidence of Duolingo's effectiveness in improving speaking proficiency.

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Variability in instructional methods could also have affected the outcomes. Although both the experimental and control groups were taught by the same instructor, differences in the teaching styles, pacing, and materials used for each group may have introduced unintended variability in the results. The CG, in particular, received traditional instruction that was limited to specific materials and methods, which might not reflect the full spectrum of classroom-based speaking instruction, thus reducing the comparability of the two groups. Another limitation is the inconsistent use of Duolingo outside the classroom. Although the participants in the EG interacted with Duolingo in a controlled classroom setting, the study did not track how much they engaged with the app outside of class. This lack of monitoring introduces variability in how the app was used, which could have affected the results. Some participants may have used the app more frequently or in different ways than others, potentially influencing the overall assessment of its effectiveness.

To address these limitations and improve future research, several suggestions can be made. One important step would be to increase the sample size and diversity of participants. Future studies could include a broader range of learners, representing different age groups, language backgrounds, and proficiency levels, to see whether the findings are consistent across varied populations. A longitudinal study design would also be beneficial for understanding the long-term effects of using Duolingo for language learning. By measuring speaking proficiency over an extended period, researchers could gain more insight into how learners retain language skills and whether the app has lasting effects on their proficiency.

Moreover, exploring the factors that motivate learners to use Duolingo could be another area for future research. Understanding how engagement with the app correlates with improvements in language proficiency would help identify the key drivers of success. This might include examining learners' intrinsic motivation, as well as their attitudes toward technology, to determine how these factors influence their success with the app. Controlling for external variables, such as prior exposure to English or familiarity with technology, would help strengthen future studies. By accounting for these factors, researchers can ensure that differences in outcomes between the experimental and control groups are due to the instructional method itself, rather than confounding variables. In addition, comparative studies between Duolingo and other language learning apps could provide a more comprehensive understanding of its effectiveness. By comparing Duolingo

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with apps like Babbel or Memrise, researchers could assess which features—such as gamification or personalized feedback—are most impactful in improving speaking proficiency. Finally, future studies could focus on specific sub-skills of speaking, such as pronunciation, fluency, or accuracy, instead of measuring overall speaking proficiency. This would allow for a more detailed understanding of how Duolingo contributes to different aspects of speaking, helping to clarify its strengths and weaknesses in language acquisition.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the ethics committee of Islamic Azad University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection, and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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