

Investigating the effect of Duolingo's sounds feature on EFL students' phonemic accuracy and perceptions

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Abstract

Previous studies on Duolingo have largely focused on learners' general speaking ability and motivation, while the effects of its speech-recognition features on learners' phonemic accuracy, particularly vowel and consonant production, remain underexplored. This study investigated the effectiveness of Duolingo's *Sounds* feature in improving EFL students' phonemic accuracy and explored their perceptions of its use in learning English pronunciation. A sequential explanatory mixed-methods design was employed involving 35 eleventh-grade students at MAN 1 Blitar. Quantitative data were collected through phonemic pre-tests and post-tests and analyzed using descriptive statistics and paired-sample t-tests. Qualitative data were obtained through semi-structured interviews with eight purposively selected students representing high, medium, and low achievement levels. The findings revealed a significant improvement in phonemic accuracy, with mean scores increasing from 81.71 in the pre-test to 93.29 in the post-test ($t(35) = -11.571, p < .001$). Students also reported positive perceptions of the feature, citing increased pronunciation awareness, confidence, motivation, and opportunities for independent practice despite some challenges with feedback clarity and difficult phonemes. The study suggests that speech-recognition-based mobile learning can effectively support phonemic development in EFL contexts.

Keywords: Duolingo sounds feature; EFL learners; phonemic accuracy; learning pronunciation; MALL

Introduction

In today's globalized world, English proficiency has become increasingly important for academic, professional, and international communication purposes (Abdalla & Mohammed, 2020). As English continues to function as a global language, learners are expected not only to master vocabulary and grammar but also to communicate effectively through accurate pronunciation (Sawalmeh & Dey, 2023). Pronunciation plays a crucial role in speaking because it helps speakers convey their ideas clearly and enhances communication effectiveness (Bajorek, 2017; Thi et al., 2021). However, pronunciation remains one of the most challenging aspects of learning English, particularly for English as a Foreign Language (EFL) learners. English pronunciation presents unique difficulties because of its complex phonetic system, diverse regional accents, and the existence of sounds that may not be found in learners' native languages (Abraham et al., 2025; Rohmana et al., 2025). As a component of speaking performance, pronunciation involves the production of speech sounds, including vowels, consonants, stress, rhythm, and intonation. Within pronunciation, phonemic accuracy specifically refers to the ability to recognize and accurately produce individual phonemes that distinguish meaning. Therefore, phonemic accuracy represented a more specific aspect of pronunciation and a fundamental to effective spoken communication. Developing these skills can be particularly challenging for EFL learners whose first language differs substantially from English in terms of its sound system.

For Indonesian EFL learners, pronunciation difficulties are often caused by substantial differences between the English and Indonesian sound systems. Several English phonemes, such as /θ/ in *think* and /ð/ in *this*, do not exist in Indonesian, making them difficult for learners to recognize and produce accurately (Rahayu, 2024). Previous studies have reported that Indonesian learners frequently struggle with distinguishing similar vowel and consonant sounds, which may affect intelligibility and communication effectiveness (Arika Pusparini et al., 2025; Illiyyin et al., 2022). These challenges indicate the importance of developing learners' phonemic accuracy, particularly their ability to accurately produce English vowels and consonants.

The relatively low level of English proficiency in Indonesia further highlights this issue. According to the EF English Proficiency Index (2023–2024), Indonesia remains in the low-proficiency category compared to many other countries. This condition suggests that improving English language competence, including pronunciation, continues to be an important concern for educators and learners. At the same time, rapid technological development and increasing internet accessibility have created new opportunities for language learning. Data from the *Asosiasi Penyelenggara Jasa Internet Indonesia* (2024) show that internet usage in Indonesia has reached a significant proportion of the population,

enabling learners to access various digital learning platforms through mobile devices.

One of the most popular language learning applications is Duolingo. The application incorporates speech-recognition technology that allows learners to practice pronunciation and receive immediate feedback on their spoken production (Siregar et al., 2024). Such technology supports the principles of Mobile-Assisted Language Learning (MALL), which emphasizes flexibility, learner autonomy, and accessibility in language learning (Renova & Kurniawan, 2025). Through repeated practice and instant feedback, learners can engage in pronunciation learning beyond the classroom environment.

Despite these advantages, speech-recognition technology also presents several limitations. The effectiveness of feedback depends largely on the accuracy of sound detection systems and learners' pronunciation performance (Addiningruum et al., 2025; Rizki et al., 2023). In many cases, feedback is restricted to indicating whether pronunciation is acceptable or not, without providing detailed explanations regarding specific phonemic errors or articulation adjustments (Nushi & Egbali, 2017). Consequently, questions remain regarding the effectiveness of mobile applications in developing learners' phonemic accuracy, particularly in producing individual vowels and consonants.

Recently, Duolingo introduced the "Sounds" feature, which focuses specifically on pronunciation practice through activities targeting individual phonemes. Unlike general speaking exercises, this feature is designed to help learners recognize and produce English sounds through repeated practice and speech-recognition feedback. Considering its relatively recent introduction, empirical evidence regarding its effectiveness remains limited, especially in EFL contexts.

Previous studies have investigated Duolingo from various perspectives. reported that Duolingo contributed positively to students' fluency and pronunciation development. While, Novitasari and Purnamaningsih (2022) found AI-assisted language learning applications supported pronunciation learning. Similarly, studies by Pusparini et al. (2025) and Buriyanti (2024) shows the positive impact of Duolingo on learners' motivation, engagement, and learning experiences. However, these studies primarily examined pronunciation as part of broader speaking performance or focused on affective factors rather than specific phonological outcomes. More recently, Balčytė and Skerstonaitė (2024) investigated the effect of Duolingo on learners' vowel pronunciation through minimal-pair analysis and found improvements in several vowel contrasts.

Nevertheless, their study focused exclusively on vowel production and did not examine consonant accuracy or learners' perceptions of the learning process. Furthermore, the findings suggested that not all phonemes benefited

equally from technology-assisted pronunciation training, indicating the need for further investigation into the effectiveness of pronunciation-focused features. Second, limited research has examined the effectiveness of Duolingo's newer "Sounds" feature, which was developed specifically for pronunciation practice. Third, most previous studies relied on either quantitative or qualitative approaches, whereas a combination of both approaches may provide a more comprehensive understanding of learning outcomes and learner experiences.

Therefore, this study employed a sequential explanatory mixed-methods design to investigate the effectiveness of Duolingo's "Sounds" feature on students' phonemic accuracy and to explore students' perceptions of its use in pronunciation learning. This study hypothesized that there would be a statistically significant difference between students' phonemic accuracy before and after using Duolingo's "Sounds" feature, with post-test scores expected to be higher than pre-test scores. By addressing the identified theoretical and empirical gaps, this study contributes to the growing body of research on Mobile-Assisted Language Learning and provides empirical evidence regarding the potential of Duolingo's *Sounds* feature to support phonemic development in EFL contexts.

Accordingly, the research questions are as follows:

- (1) How effective is Duolingo's "Sounds" feature in improving the phonemic accuracy of EFL students at MAN 1 Blitar?
- (2) What are students' perceptions of using Duolingo's "Sounds" feature for?

Literature review

Pronunciation and phonemic accuracy

Pronunciation is an essential aspect of oral communication because it affects speech intelligibility and listeners' comprehension. To achieve accurate pronunciation, learners need to understand how speech sounds are produced. According to Odgen (2012), accurate pronunciation is determined by three main aspects of speech production: voicing, place of articulation, and manner of articulation. Differences in any of these aspects may result in inaccurate sound production and potentially lead to misunderstanding. Therefore, developing accurate pronunciation requires learners to recognize and produce speech sounds according to their phonetic and phonological characteristics.

One important component of pronunciation is phonemic accuracy, which refers to learners' ability to accurately produce individual phonemes, particularly vowels and consonants, in accordance with target-language norms. Phonemic accuracy plays a crucial role in EFL learning because inaccurate phoneme production may reduce intelligibility and hinder effective communication (Febriyani et al., 2026). Research has shown that phonemic errors are often influenced by first-language interference and incomplete phonological

acquisition, causing learners to rely on familiar sound patterns from their native language when producing target-language sounds (Derwing & Munro, 2015).

In EFL contexts, phonemic accuracy is particularly important because English contains vowel and consonant sounds that may not exist in learners' first language (Sitinjak et al., 2026). As a result, learners frequently experience difficulties in accurately producing specific phonemes, which can affect communication effectiveness. Therefore, improving phonemic accuracy has become an important goal of pronunciation instruction, particularly through technology-assisted learning environments that provide opportunities for repeated practice and corrective feedback.

Mobile-Assisted Language Learning (MALL)

Mobile-Assisted Language Learning (MALL) refers to the use of mobile technologies to support language learning beyond traditional classroom settings. MALL promotes flexibility, learner autonomy, and continuous access to learning materials through smartphones and mobile applications (Burstion, 2014; Metruk, 2024). Previous studies have consistently shown that mobile learning environments increase learner engagement and provide opportunities for repeated practice and immediate feedback, which are essential for pronunciation development. In pronunciation learning, frequent exposure to target sounds and opportunities for self-correction enable learners to refine their speech production and improve phonological accuracy.

DeKeyser (2020) in his skill acquisition theory stated that repeated practice plays an important role in the development of language skills by helping learners gradually transform explicit knowledge into more automatic performance. In pronunciation learning, frequent exposure to target sounds and repeated opportunities to produce them can strengthen phonological representations and improve articulatory accuracy. Immediate feedback further supports this process by enabling learners to notice discrepancies between their production and target forms and make necessary adjustments. Therefore, mobile applications that combine repetitive pronunciation practice with speech-recognition feedback, such as Duolingo's Sounds feature, may facilitate the development of learners' phonemic accuracy, particularly in producing English vowels and consonants.

Duolingo's "Sounds" Feature for Pronunciation Learning

Duolingo is one of the most widely used language-learning applications and incorporates speech-recognition technology to support pronunciation practice. Its *Sounds* feature specifically focuses on helping learners recognize and produce English vowels and consonants through listening, repetition, and feedback activities. Learners are exposed to pronunciation models, asked to imitate target sounds, and receive immediate feedback regarding their

performance. Consistent with Skill Acquisition Theory, these repeated pronunciation exercises may strengthen learners' phonemic awareness and gradually improve phonemic accuracy.

Nevertheless, the effectiveness of speech-recognition technology remains debatable. Although immediate feedback may support pronunciation practice, previous studies have noted that many applications provide only simple correctness judgments without detailed explanations regarding articulation errors or phoneme production (Nushi & Eqbali, 2017; Rizki et al., 2023). Consequently, further investigation is needed to determine whether Duolingo's Sounds feature can effectively support learners' phonemic development.

Previous Studies on Duolingo and Pronunciation Learning

Previous studies have generally reported positive effects of Duolingo and other MALL applications on pronunciation learning, learner motivation, and engagement (Pusparini et al., 2025; Buriyanti, 2024; Widuri & Sari, 2024). A common finding across these studies is that mobile applications provide flexible learning opportunities and encourage autonomous practice. However, most studies evaluated pronunciation as part of broader speaking performance rather than examining phonemic accuracy specifically.

Research focusing on technology-assisted pronunciation learning has also produced mixed findings. Some studies reported improvements in learners' pronunciation after repeated exposure and practice, whereas others found that limited feedback quality reduced learning effectiveness (Illiyyin et al., 2022). Moreover, recent studies investigating Duolingo primarily examined learners' motivation, perceptions, or general pronunciation outcomes, with limited attention given to the application's newer 'Sounds' feature. Methodologically, most previous studies relied on either quantitative or qualitative approaches, resulting in a fragmented understanding of both learning outcomes and learner experiences.

These unresolved issues indicate both theoretical and empirical gaps. Theoretically, limited research has examined pronunciation improvement from the perspective of phonemic accuracy rather than general speaking performance. Empirically, little evidence exists regarding the effectiveness of Duolingo's Sounds feature in developing learners' phonemic accuracy. Furthermore, few studies have combined quantitative measures of pronunciation improvement with qualitative exploration of learner perceptions. Therefore, the present study employs a sequential explanatory mixed-methods design to investigate the effectiveness of Duolingo's Sounds feature in improving phonemic accuracy while simultaneously exploring students' perceptions of its use in pronunciation learning.

Methods

Research Design

This study employed a sequential explanatory mixed-methods design adapted from Creswell (2018), in which quantitative data collection and analysis were conducted in the first phase, followed by qualitative data collection and analysis in the second phase to explain and elaborate the quantitative findings. The quantitative phase used a one-group pretest–posttest pre-experimental design to examine the effectiveness of Duolingo’s Sounds feature on students’ phonemic accuracy. The qualitative phase adopted a case study qualitative approach to explore students’ perceptions and learning experiences related to the use of Duolingo’s Sounds feature.

Research Participants

The participants of this study were 35 eleventh-grade students of MAN 1 Blitar who participated in the quantitative phase. They were selected through simple random sampling from the target population. For the qualitative phase, eight students were selected purposely based on their post-test achievement levels, representing high-, medium-, and low-achieving groups. In addition, all selected participants had prior experience using Duolingo’s Sounds feature during the intervention, enabling them to provide rich and relevant insights into its use. This selection allowed the researcher to obtain diverse perspectives regarding the effectiveness and usability of Duolingo’s Sounds feature.

Research Instruments

The quantitative instrument consisted of a phonemic accuracy test administered as a pre-test and post-test. Students’ performances were assessed using a phonemic accuracy rubric adapted from Celce-Murcia et al. (2010), which evaluated four aspects: vowel accuracy, consonant accuracy, consistency of pronunciation, and speech clarity. Each aspect was assigned equal weighting in the overall score. The test and scoring rubric were validated through expert judgment by one of the English teachers at MAN 1 Blitar and one lecturer in English Language Education, who evaluated the content validity, clarity, and appropriateness of the assessment criteria. Based on their feedback, several revisions were made prior to the implementation of the instruments. To enhance scoring reliability and minimize assessment bias, students’ pronunciation performances were independently evaluated by two raters, namely the researcher and the English teacher. Both raters used the same validated scoring rubric for assessing the pre-test and post-test performances. In addition, semi-structured interview guidelines were developed and validated to explore students’ perceptions and experiences of using Duolingo’s Sounds feature.

Data Collection

Quantitative and qualitative data were collected sequentially following the explanatory mixed-methods design. In the quantitative phase, students completed a phonemic accuracy pre-test before the intervention and a post-test after the intervention. The intervention was conducted over three weeks and consisted of six treatment sessions using Duolingo's Sounds feature. During each session, students practiced English pronunciation through speech-recognition-based activities focusing on vowels and consonants provided by the application. Documentation in the form of photographs and audio recordings was also collected to support the quantitative data.

Following the quantitative phase, qualitative data were collected through semi-structured interviews with eight selected students. The participants represented different achievement levels (high, medium, and low) and had experience using Duolingo's Sounds feature throughout the intervention. The interviews were conducted to explore students' perceptions, experiences, benefits, and challenges related to pronunciation learning through the application. Audio recordings and interview transcripts were used as supporting qualitative data.

Research Procedures

The intervention was conducted over three weeks and consisted of six treatment sessions, with two sessions scheduled each week according to the school's English class timetable. The duration of each session varied depending on the allocated instructional time, ranging from one to two class periods each one period of class is 40 minutes.

During the treatment, students used Duolingo's Sounds feature to practice English pronunciation through speech-recognition-based exercises. The activities involved listening to pronunciation models, repeating target sounds, and receiving immediate feedback from the application. The pronunciation exercises focused on English vowels and consonants provided within the application and were aligned with the phonemic aspects assessed in the research instrument. Since the exercises were generated according to the learning sequence available in Duolingo, the specific phonemes practiced varied across sessions.

The intervention was facilitated by the researcher, who was responsible for implementing all treatment activities. The classroom teacher did not directly conduct the intervention but assisted in evaluating students' pre-test and post-test performances to enhance scoring reliability.

Data Analysis

The quantitative data were analyzed using descriptive statistics to determine the mean scores and score distribution of the pre-test and post-test

results. Prior to hypothesis testing, a Shapiro–Wilk test was conducted to examine data normality. A paired-sample t-test was subsequently performed to determine whether a significant difference existed between students' phonemic accuracy before and after the intervention.

The qualitative data obtained from the interviews were analyzed using the interactive model proposed by (Miles et al., 2014). Interview transcripts were first condensed by selecting and coding relevant statements. The codes were then organized into themes, displayed in thematic categories, and subsequently interpreted to draw and verify conclusions regarding students' perceptions of Duolingo's *Sounds* feature.

Findings

This section presents the findings of the study related to the (1) effectiveness of Duolingo's *Sounds* features on students' phonemic accuracy and (2) students' perceptions of using its features which were derived from quantitative and qualitative data.

1. *The effectiveness of Duolingo's Sounds features on students' phonemic accuracy*

This section discusses the result of the first research question regarding the effectiveness of Duolingo's *Sounds* feature on students' phonemic accuracy. The findings were obtained from the analysis of students' pre-test and post-test scores on phonemic accuracy after the implementation of Duolingo's "Sounds" feature. The results showed that there was an improvement in students' pronunciation performance after the treatment. The mean score of the post-test was higher than the pre-test score, indicating positive development in students' phonemic accuracy. The descriptive statistics of students' phonemic performance are presented in Table 1 below.

Table 1

Pre-test and Post-test Results of Students' Phonemic Accuracy

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	35	65	100	81.71	10.775
Post-test	35	75	100	93.29	5.934

(Source: Research's Data, 2026)

As shown in Table 1, the mean score increased from 81.71 in the pre-test to 93.29 in the post-test, indicating an improvement of 11.58 points after the

implementation of Duolingo's *Sounds* feature. In addition to the increase in the mean score, the standard deviation decreased from 10.775 in the pre-test to 5.934 in the post-test. This suggests that students' performance became more consistent after the treatment, as the variation among students' scores was lower in the post-test. Furthermore, the minimum score improved from 65 to 75, while the maximum score remained at 100, indicating that both lower- and higher-achieving students showed improvement in phonemic accuracy. To determine whether the improvement was statistically significant, a paired sample t-test was conducted. The results of the statistical analysis are presented in Table 2.

Table 2.*Paired Sample T-Test Output*

				95% Confidence interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig (2-tailed)
Pair 1	Pretest Post test	-11.571	6.942	1.173	-13.956	-9.187	-9.861	34	< .001

(Source: SPSS Output, 2026)

Table 2 reveals that the significance value (Sig. 2-tailed) was lower than 0.05, namely < .001. It indicates that there was a significant difference between the pre-test and post-test scores. In addition, the mean difference between the scores was -11.571, which shows improvement in students' phonemic accuracy after the treatment. Based on these findings, the alternative hypothesis (H_1) was accepted, while the null hypothesis (H_0) was rejected. Therefore, it can be concluded that Duolingo's *Sounds* feature had an effect on students' phonemic accuracy, especially in producing English vowels and consonants.

2. *Students' perceptions of using Duolingo's "Sounds" feature*

This section discusses the result of the second research question regarding the students' perceptions of using Duolingo's sound features. The findings were obtained from semi-structured interviews with 8 selected students after the implementation of Duolingo's *"Sounds"* feature. The participants were chosen using purposive sampling to represent different levels of learning performance and engagement. Specifically, the students consisted of two high scores students, two medium scores students, two low scores students who had experience using Duolingo before the treatment. The findings were organized into several themes based on students' responses.

3. Increasing Learning Motivation

Students reported that Duolingo's "Sounds" feature increased their motivation to practice pronunciation. One participant explained that the application made her feel more curious to continue practicing pronunciation P6 Stated "Because the exercises make me curious and I want to keep trying." (P6) Another participant (P5) stated that she became more interested in practicing pronunciation regularly: "Yes, I became more interested in practicing pronunciation every time." Some students (P2) also mentioned that they could practice anytime using their mobile phones: "Yes, because I can practice anytime using my phone."

4. Creating Enjoyable Learning Experiences

Students described their learning experience using Duolingo as more enjoyable compared to conventional learning. One participant stated (P5) "It is more fun because the animations are cute and the application is interactive." Another participant (P2) explained that the learning process felt more relaxed "It is more relaxed and not boring compared to usual practice." One student (P4) also stated that the application made learning more enjoyable than textbook-based learning "It is much more enjoyable compared to just learning from books or being asked to read."

5. Increasing Confidence in Pronunciation Practice

Students reported that Duolingo helped them become more confident in pronunciation practice. One participant stated (P4) "I can practice many times before speaking directly, so I am not afraid of making mistakes." Another participant (P7) explained that she felt more confident after practicing independently "It is quite helpful because I can practice first before speaking in class." One student (P8) also stated that she felt more confident when pronouncing difficult sounds "I became more confident when pronouncing difficult vowel and consonant sounds."

6. Providing Flexible Learning Opportunities

Students reported that Duolingo allowed them to learn flexibly anytime and anywhere. One participant stated (P2) "I can use it anytime on my phone, so it is easier to practice by myself without waiting for the teacher." Another participant (P7) explained "It is very fun and flexible because it can be used anytime and anywhere." One student (P8) also stated "I can practice at home using my phone, so I can practice anywhere and anytime."

7. *Helping Students Improve Pronunciation Skills*

Students reported that Duolingo helped them improve pronunciation by providing examples they could imitate. One participant (P2) stated “Because there is a pronunciation example, I can directly follow how to pronounce it.” Another participant (P3) explained “Because it provides sound examples, I can directly imitate the pronunciation.”

8. *Increasing Pronunciation Awareness*

Students reported that they became more aware of correct pronunciation after using Duolingo. One participant (P1) stated “Now after using the application, I become more aware of what correct pronunciation is like.” Another participant (P7) added “I become more aware of correct English pronunciation.” One participant (P1) also stated “Previously, I often just read without paying attention to pronunciation.”

9. *Providing Pronunciation Feedback*

Students reported that Duolingo provides feedback on pronunciation accuracy. One participant (P4) stated “I know whether my pronunciation is correct or wrong from the application feedback. Another participant (P5) explained “I can see whether my pronunciation is correct or incorrect because of the correction feature.” One participant also (P1) stated “If I make a mistake, it only shows it is wrong, but it does not explain where the mistake is.” (P1)

10. *Difficulties in Pronouncing Certain Sounds*

The interview results showed that students experienced difficulties in pronouncing certain English phonemes, especially sounds that do not exist in Bahasa Indonesia such as /θ/ and /ð/. One student stated “The most difficult sounds are /θ/ and /ð/, I need to repeat them several times before I can pronounce them correctly. Students also reported that repetition was needed to improve their pronunciation accuracy.

11. *Lack of Detailed Pronunciation Feedback*

Although students acknowledged that Duolingo provided feedback on their pronunciation performance, some reported that the feedback lacked detailed explanations. Students stated that the feedback provided by Duolingo was helpful but limited. One student explained “When I make a mistake, it only shows it is wrong, but it does not explain where my mistake is.” This shows while the application helps learners identify whether their pronunciation is correct or incorrect, it does not always provide sufficient information about the specific pronunciation errors that need improvement.

Discussion

The present study examined the effectiveness of Duolingo's "Sounds" feature on students' phonemic accuracy and explored students' perceptions in using it. The first findings of this study reveal that Duolingo's *Sounds* feature was effective in supporting students' phonemic accuracy. It was proven by the statistically significant difference between the pre-test and post-test scores, indicating that the use of the application contributed to more accurate production of English speech sounds. This is in line with Ahmed et al. (2022), positively affected learners' speaking accuracy by providing opportunities for regular pronunciation practice. Likewise, Loewen et al. (2019) argued that the structured features of Duolingo encourages learners to engage in more frequent language practice. This finding can be attributed to the application ability in providing repeated pronunciation practice, immediate feedback, enabling learners to engage continuously in pronunciation learning and gradually develop more accurate production of English speech sounds.

Furthermore, the findings regarding students' perception in using Duolingo "Sounds" Feature reveals that students experienced increased motivation when using it. This can be interpreted through the lens of MALL theory, which emphasizes learner autonomy and engagement through mobile-based learning tools (Renova & Kurniawan, 2025). The flexibility of Duolingo allows students to practice pronunciation independently, which aligns with the concept of self-regulated learning. This finding is consistent with Widuri and Sari (2024), who reported that mobile applications increase students' engagement in language learning. However, the present study extends this finding by showing that motivation is not only related to engagement but also to the ability to repeat pronunciation tasks without time limitations, which enhances confidence in speaking English.

Another important finding is that students perceived Duolingo as an accessible and practical learning tool. This supports the idea that mobile technology facilitates learning outside the classroom environment. According to Siregar et al. (2024), speech recognition-based applications provide immediate feedback that helps learners improve their pronunciation skills. In this study, students affirmed that they could practice anytime and anywhere, which reinforces the concept of flexible learning environments. This result is in line with previous research by Novitasari and Purnamaningsih (2022), who found that Duolingo supports independent learning. However, this study further reveals that accessibility alone is not sufficient; students also require repeated exposure to improve pronunciation accuracy.

A significant finding of this study is related to students' difficulties in producing certain phonemes, particularly sounds that do not exist in Bahasa Indonesia such as /θ/ and /ð/. This is consistent with Celce-Murcia et al. (2010),

who emphasize that segmental features are often challenging for EFL learners due to differences between L1 and L2 sound systems. The present study supports this theory by showing that phonemic interference from the first language remains a major barrier in pronunciation learning. Interestingly, despite repeated exposure through Duolingo, some students still required multiple attempts to produce accurate sounds, indicating that technological input alone may not fully replace explicit pronunciation instruction.

Another key finding is the role of feedback provided by Duolingo's speech recognition system. Students reported that the feedback was helpful but limited, as it only indicated correctness without explaining articulation errors. This finding is particularly important because it shows a lack in automated pronunciation tools. While previous studies such as Rizki et al., (2023). argue that speech recognition technology enhances pronunciation learning through instant feedback, this study shows that the effectiveness of feedback depends on its depth and clarity. The limitation of feedback may reduce its impact on developing precise phonemic awareness, especially for difficult sounds.

Overall, the findings suggest that Duolingo's "Sounds" feature contributes positively to students' phonemic learning, particularly in increasing motivation and providing opportunities for repeated practice. However, the effectiveness of the application is still limited by the lack of detailed corrective feedback and the persistent challenges of L1 phonological interference. These results indicates that while mobile applications are effective supplementary tools, they should be integrated with teacher guidance to maximize pronunciation learning outcomes.

In conclusion, this study confirms that Duolingo's Sounds feature can support the development of EFL learners' phonemic accuracy through repeated pronunciation practice and immediate feedback. Beyond demonstrating improvements in phonemic accuracy, this study contributes to the literature by specifically examining Duolingo's Sounds feature, a relatively underexplored tool designed for phoneme-focused pronunciation practice. Furthermore, the use of a sequential explanatory mixed-methods design provides a more comprehensive understanding of pronunciation learning by integrating statistical evidence of improvement with learners' perceptions and experiences. The results further enrich MALL research by providing evidence that speech-recognition-based applications can facilitate phonemic development in EFL learning environments.

Conclusion

This study investigated the effectiveness of Duolingo's *Sounds* feature in improving EFL students' phonemic accuracy and explored students' perceptions of its use in pronunciation learning. The findings revealed that the feature

significantly had an effect on students' phonemic accuracy and was positively perceived as a helpful, motivating, and flexible tool for pronunciation practice. At the same time, students reported difficulties in pronouncing unfamiliar phonemes and noted that the feedback provided by the application lacked detailed explanations of pronunciation errors. These results suggest that speech-recognition-based activities and repeated pronunciation practice can support learners' development of English vowel and consonant production.

This study contributes to the field of Mobile-Assisted Language Learning (MALL) by investigating the effectiveness of Duolingo's *Sounds* feature which remains underexplored in EFL research. In addition, unlike many earlier studies that examined either learning outcomes or learner perceptions separately, this study provides a more comprehensive understanding by investigating both the effectiveness and students' perceptions of Duolingo's use in pronunciation learning. However, the findings are limited to a single educational context and short intervention period. Future research is recommended to involve larger samples, longer implementation periods, and broader pronunciation aspects, including suprasegmental features, to further examine the potential of technology-assisted pronunciation learning.

Ethical Approval

This study involved human participants, namely 11th-grade students at MAN 1 Blitar. Therefore, ethical considerations were applied throughout the research process. Permission to conduct the study was obtained from the school administration prior to data collection. All participants were informed about the purpose of the study and participated voluntarily. The confidentiality of the participants' identities and responses was maintained, and all data were used solely for academic purposes. This study adhered to ethical principles of research involving human subjects, including respect, anonymity, and non-maleficence.

Use of artificial intelligence (AI)

The authors declare that the generative artificial intelligence (AI) tool ChatGPT and Grammarly was used exclusively for language editing, paraphrasing, and grammatical improvement during the preparation of this manuscript. The use of AI did not influence the scientific content, research design, data analysis, data interpretation, results, or conclusions of the study. Full responsibility for the integrity, originality, and accuracy of the manuscript remains with the authors.

Conflict of Interest

The authors declare no conflict of interest.

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