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The MALL Effect on EFL Learners' Attitudes, Cognitive Load, and Performance in Learning Pronunciation

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ABSTRACT

The integration of technology in education, particularly in English Language Teaching (ELT), has significantly enhanced engagement, motivation, and learning outcomes. Mobile-Assisted Language Learning (MALL) has become a powerful tool, offering innovative opportunities for language learners. This study examined the effects of MALL on Iranian EFL learners' attitudes, cognitive load, and pronunciation performance. Participants were divided into experimental and control groups, with the experimental group using the ELSA app for pronunciation practice. Data were collected through questionnaires, interviews, and pronunciation assessments. The findings showed that the experimental group had a positive attitude toward using MALL for pronunciation practice. Additionally, learners experienced a reduction in cognitive load, suggesting that mobile learning tools ease the mental effort involved in language acquisition. A significant negative correlation was found between cognitive load and pronunciation performance, indicating that lower cognitive load led to better pronunciation outcomes. These results highlight the potential of MALL to enhance learners' engagement and pronunciation skills while reducing cognitive load. The study highlights the potential of MALL to facilitate pronunciation learning by providing an accessible and interactive platform for learners.

***KEYWORDS*:** mobile-assisted language learning, learners' attitudes, cognitive load, pronunciation

1. Introduction

Mobile technology has become an essential part of daily life, driving its integration into various fields, including language learning (Social, 2021). Information and Communication Technology (ICT) has enabled easier access to information, and with the rise of cognitive and sociolinguistic approaches in language teaching, the late 1980s and early 1990s saw a shift toward using technology in classrooms (Baleghizadeh & Oladrostam, 2010). Mobile-assisted language learning (MALL) is an umbrella term encompassing all language-learning activities that utilize mobile devices (Cho et al., 2018). Mobile technologies have great potential to enhance second language learning by providing convenient access to materials (Kondo, 2012). The availability of mobile devices facilitates contextualized learning, making education more relevant to real-life situations (Ameri, 2020). It also fosters both formal and informal learning, offering flexible language acquisition opportunities inside and outside the classroom (Sulaiman, 2019).

The rapid growth of mobile technologies is reshaping cultural practices and creating new learning opportunities (Pachler, 2010). However, their integration into education has been gradual, as teachers must figure out how to incorporate them effectively (Kukulska-Hulme & Shield, 2008). There is also a need for strategies and resources tailored to Mobile-Assisted Language Learning (MALL). MALL, though a relatively young field, has seen extensive research over the past two decades;

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more recent research includes works by Mortazavi (2021), Lei (2022), and Adijaya (2023). MALL has also become a growing area of research in Iran's language learning and teaching contexts.

Morady Moghadam et al. (2024) conducted a systematic review of 70 studies on Mobile-Assisted Language Learning (MALL) in Iran to identify research trends, underexplored areas, and future directions for integrating mobile technologies into language education. Their findings revealed that most studies focused on vocabulary learning (Al-Abri et al., 2024; Fithriani, 2021). Other areas of focus included grammar knowledge (Parsa & Anjomshoa, 2022), reading comprehension (Jamshidi & Mohamadi Zenouzagh, 2020; Khubyari & Narafshan, 2016), listening comprehension (Azar & Nasiri, 2014), writing accuracy, fluency, and complexity (Ebadijalal & Yousofi, 2023), and speaking development (Aliakbari & Mardani, 2022). Additionally, studies explored idiom learning (Ghanizadeh, 2022) and attitudes toward MALL (Namaziandost, 2021; Rahmani, 2022).

Many of these studies employed quantitative research designs and were primarily conducted in private language institutes, where experimental studies are easier to implement. However, research on the impact of MALL on pronunciation remains limited, which could restrict a comprehensive understanding of how mobile technology can enhance pronunciation skills (Arashnia & Shahrokhi, 2016).

A major challenge for learners of English as a foreign language is mastering pronunciation, which is a crucial aspect of language proficiency. Acquiring accurate English pronunciation is particularly difficult and requires significant time and effort (Aliaga García, 2007; Gilakjani, 2016). Clear and intelligible pronunciation is essential for effective communication and plays a key role in language instruction. Proper pronunciation facilitates learning, whereas poor pronunciation can create significant obstacles in the language acquisition process. While non-native speakers may not achieve native-level fluency, language role models should still demonstrate adequate proficiency (Kosanke, 2019). Therefore, it is essential to reevaluate the role of pronunciation in English language instruction within EFL classrooms. Mastery of grammar and an extensive vocabulary do not necessarily ensure effective spoken communication without proper pronunciation. On the other hand, clear pronunciation can make a speaker intelligible despite errors in other speaking subskills. Thornbury (2006, p. 185) emphasized that "faulty pronunciation is one of the most common causes of misunderstanding." Even when learners perform well in other areas of communication, inadequate pronunciation can obstruct meaningful and effective interaction.

Precise pronunciation can also influence an individual's social standing, as a noticeable foreign accent may be viewed unfavorably by native speakers, potentially resulting in social or professional discrimination for ESL/EFL learners (Derwing & Munro, 2005). Consequently, pronunciation intelligibility is essential for effective oral communication, serving as a fundamental aspect of communicative competence (Celce-Murcia & Goodwin, 2000). Iranian EFL teachers also face additional challenges, including a lack of suitable textbooks, materials, and expertise in teaching pronunciation.

Pronunciation is crucial for effective communication, but ESL/EFL instruction often falls short due to a lack of tailored strategies and structured methods. From a cognitive perspective, using research-based techniques can improve learning environments. Cognitive load, or the mental effort on working memory, plays a key role—excessive load hinders comprehension, while reducing it enhances understanding (Deleeuw & Mayer, 2008). Based on the above-mentioned issues, this study tried to examine the effect of learning pronunciation through MALL on Iranian EFL learners' attitudes, cognitive load, and performance by developing the following research questions:

1. What are Iranian EFL learners' attitudes toward learning pronunciation via MALL programs?
2. What is the effect of pronunciation learning in the MALL environment on the EFL learners' cognitive load?
3. What is the effect of pronunciation learning in the MALL environment on EFL learners' performance?
4. Is there a relationship between EFL learners' cognitive load and performance in the MALL context?

2. Literature Review

2.1. Technology for Language Learning & Teaching

The rapid advancement of communication technologies has transformed language teaching, enabling new forms of discourse and participation (Keren, 2012). In this line, educators have long used technology to enhance language learning (Shadiev & Yang, 2020). Technology, defined as methods and knowledge to achieve tasks (Merriam-Webster, 2016), offers limitless resources for language learners (Bull & Ma, 2001).

Research shows that technology in the classroom can be as effective as traditional methods (Shadiev & Huang, 2019). Sabzian (2013) noted that it fosters greater collaboration between teachers and students, boosting learner confidence and Drayton (2010) emphasized that computer-based classrooms offer authentic learning experiences that promote student responsibility. Moreover, Parvin and Salam (2015) found that technology enhances learners' exposure to language in meaningful contexts, helping them build knowledge. The literature highlights that technology fosters teacher-student interaction, provides comprehensible input, enhances critical thinking, shifts focus to student-centered learning, promotes autonomy, boosts confidence, and increases motivation in foreign language learning.

2.2. MALL in Language Learning and Teaching

The term Mobile Assisted Language Learning (MALL) was introduced by Chinnery (2006), who suggested that mobile devices could serve as effective tools for language learning. However, studies and publications on the use of mobile devices in foreign language teaching and learning date back to 1994 (Burston, 2013). MALL has evolved into a growing field of research, driven by advancements in mobile technologies and the widespread use of smartphones and tablets (Karakaya & Bozkurt, 2022).

The key benefits of MALL include enabling students to take control of their learning by choosing when, where, and how they access online materials, fostering independent and self-directed education (Burston, 2013). Additionally, using mobile devices in language learning has been shown to increase motivation by offering non-traditional teaching methods (Karsenti, 2013).

Duman (2015) analyzed studies on mobile-assisted language learning from 2000 to 2012 and found a rapid increase in research, peaking in 2012. The most common focus was teaching vocabulary using mobile devices. In a later study, Shadiev and Yang (2020) reviewed articles from 2014 to 2019, noting that writing, speaking, and vocabulary were the most prominent areas of focus. They identified 23 different technologies used a total of 406 times.

From all above-mentioned studies, a few of them focused on the use of MALL in pronunciation. Kim and Kwon (2012) concluded that ESL apps provide effective, personalized, and flexible learning opportunities. Also, Jing (2017) found that combining phonetics teaching with mobile learning positively impacted phonetics instruction. Retnomurti (2019) developed the Android app PROTADROID for pronunciation practice, finding that learners with positive attitudes towards the app successfully engaged with it.

In Iran, Morady Moghadam et al. (2024) reviewed 70 studies on MALL in Iran (2010–2023), identifying research trends, gaps, and future directions, finding that most focused on vocabulary, grammar, writing accuracy, fluency, speaking development, and idiom learning. In another study, Rahmani (2022) found that digital flashcards significantly improved short- and long-term EFL vocabulary retention in Iran. Parsa and Anjomshoa (2022) reported that mobile learning enhanced grammar achievement but had no effect on self-efficacy among male EFL learners. In addition, Aliakbari and Mardani (2022) found that WhatsApp-based EFL learners outperformed face-to-face learners in speaking skills, motivation, and satisfaction. A study conducted by Ghanizadeh (2022) revealed that Telegram-based idiom learning improved acquisition and perceptions, reinforcing MALL's effectiveness.

Despite the limited research on the effect of MALL on pronunciation, Arashnia and Shahrokhi (2016) found that mobile-based instruction significantly improved Iranian EFL learners' pronunciation. Given the scarcity of research on pronunciation, the study also examined MALL's impact on attitudes, cognitive load, and performance.

2.3. Teaching Pronunciation

Pronunciation, encompassing stress, sounds, intonation, and intelligibility, is crucial for effective communication (Nguyen, 2023). It influences social interactions, identity, and belonging. Despite the communicative shift in teaching, ELT remains literacy-focused, often neglecting pronunciation. Historically undervalued, it has been called the "Cinderella" skill (Kelly, 1969) or "an orphan" in classrooms (Gilbert, 2010).

Pronunciation is often overlooked in language teaching due to its complexity, lack of resources, and teacher uncertainty (Beramendi & Cosentino, 2019). Many students find it challenging (Robillos, 2023), and input alone is insufficient for improvement, even over years (Solon, 2016). However, targeted feedback can significantly enhance pronunciation within weeks (Kartushina, 2015). Mobile-Assisted Language Learning (MALL) presents new opportunities for personalized and effective pronunciation practice (Liakin, 2015).

2.4. Factors Affecting the Learning of Pronunciation

Recent discussion of pronunciation and research on the teaching and learning of pronunciation have focused on the following issues: the importance of accent, stress, intonation, and rhythm in the comprehensibility of the speech of nonnative speakers; the effects of motivation and exposure on the development of native-like pronunciation; and the intelligibility of speech among speakers of different English varieties.

Accent: Accent is the auditory effect of pronunciation features indicating a speaker's regional or social origin (Crystal, 2003). Many adult English learners have foreign accents, affecting intelligibility. Understanding these traits helps teachers address pronunciation issues (Derwing & Munro, 2005).

Stress, Intonation, and Rhythm: Derwing and Munro (2005) found that prosodic errors (stress, intonation, rhythm) impact intelligibility more than phonetic errors. O'Brien (2004) showed that native German speakers prioritized prosody over individual sounds when assessing American students' German accents. These findings highlight the need for pronunciation instruction to focus on both prosody and individual sounds.

Motivation and Exposure: Age of acquisition, motivation, and cultural immersion influence native-like pronunciation. Personal and professional goals, positive experiences, and attitude also play key roles (Gatbonton, 2005).

Intelligibility and Varieties of English: Jenkins' (2009) work highlighted key phonological features essential for mutual intelligibility in nonnative English communication. For adult learners, pronunciation focus should prioritize understanding over perfection.

2.5. Learners' Attitudes Toward Learning Language Through MALL

Several studies have explored attitudes toward various technologies in language learning, including mobile phones and PDAs (Teo, 2008) focused on the internet, while Corlett (2005) examined PDAs. Azar and Nasiri (2014) found that Iranian EFL learners using cell phone-based audiobooks outperformed those using traditional formats in listening comprehension. Miqawati (2020) reported positive student attitudes toward using mobile apps for pronunciation improvement. These findings align with other studies highlighting the effectiveness of mobile technology in language learning.

2.6. Cognitive Load of the EFL Learners

In education, cognition and emotion both influence learning. Cognitive load refers to the mental effort required by working memory, which can obstruct understanding (Malamad, 2011). Cognitive load theory (Sweller, 2019) highlights working memory limitations and the organization of long-term memory. There are three types of cognitive load: extraneous (linked to teaching methods), intrinsic (related to task difficulty), and germane (associated with learning strategies). Reducing cognitive load helps improve comprehension and learning efficiency by managing distractions and focusing attention on relevant information.

2.7. Performance of EFL Learners in MALL

Mobile-based learning, or MALL, enables learning across multiple contexts through personal devices, offering access beyond time and place constraints (Crompton, 2013). Unlike traditional computer-based learning, MALL supports communicative approaches and student-centered, collaborative learning. Smartphones are now essential tools for communication, work, and education, particularly in language learning and developing oral skills.

In this line, Shirmardi et al. (2023) explored the effect of game-based instruction on the English pronunciation accuracy and the motivational perception towards the game. Conducted at a school low-intermediate level students, the study compared an experimental class taught using the Spaceteam ESL application with a control class taught through the conventional instructional methods. The results revealed that the game-based instruction improved the students' pronunciation in the experimental class and enhanced their motivation to learn language compared to the students in the control class, highlighting the effectiveness of a Mobile Game-Based Application in enhancing both pronunciation proficiency and motivation.

3. Methodology

3.1. Participants

This mixed-methods study involved 60 intermediate EFL learners (30 male, 30 female) studying general English at an institute in Tabriz, Iran. Aged 19-32, they were selected through convenience sampling for a six-week program.

3.2. Instruments

To meet the objectives of the study, the following instruments were used: Pronunciation test based on a rating instrument developed by Isaacs (2016); Mobile application for pronunciation learning; Cognitive load rating scale adopted by Yang et al. (2022); Interview questions to measure students' attitudes toward using MALL to improve pronunciation.

3.2.1.Pronunciation Test Based on Rating Instrument Developed by Isaacs (2016)

This test, based on Isaacs' (2016) rating instrument, evaluates students' pronunciation before and after treatment using guidelines across six proficiency levels (A1–C2). It consists of two sections: the first includes 14 questions where participants read a set of names and select the expected pronunciation from four options; the second contains 16 questions where participants read pairs of words and determine how many identical initial sounds they share (see Appendix A).

3.2.2.Mobile Application for Pronunciation Learning

The English Language Speech Assistant (ELSA) App was used as an instrument to enhance learners' pronunciation. ELSA is an AI app with personalized English language lessons. Practicing English speech with ELSA is fun and addictive. It's an App that helps with English pronunciation. With the help of artificial intelligence and videos from native English speakers, this App helps to learn a neutral American accent. (Appendix B). This software contains 7,100+ activities, mastering English pronunciation, grammar, and vocabulary like never before. This app is powered by Artificial Intelligence (AI) that can quickly assess the users' fluency level and help them learn English, no matter what their native language is.

3.2.3. Cognitive Load Rating Scale Adopted by Yang et al. (2022)

This 20-item questionnaire assessed learners' cognitive load across five dimensions: difficulty, incompetence, negative pressure, lack of attention, and facility operational load. It used a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). A pilot study validated the questionnaire, and its high reliability was confirmed with a Cronbach's alpha of .905 (Appendix C).

3.2.4. Interview Questions to Measure Students' Attitudes toward Using MALL to Improve Pronunciation

Interview questions to measure students' attitudes toward using MALL to improve pronunciation. These three interview questions were adopted from Aratusa (2022). The questions were about the students' general perception of the usefulness of MALL, pronunciation learning, and students' perception respectively. The second item of the interview, the researcher asked the students about a special technique or way that the students do to support their pronunciation learning. The third item of the interview deals with what the students do if they encounter problems in English pronunciation learning. Relying on the question, the students answered that practice makes perfect. Practicing pronunciation makes the students improve even better.

3.3. Procedure

First of all, EFL students were randomly assigned into treatment and control groups. In order to check the students' pronunciation both groups took a pronunciation pretest. In the experimental group, during the treatment period, the ELSA application was used to enhance the pronunciation learning of the participants. Then they practiced common words using the sound. Repeating after the native speaker helped learners get close to the correct pronunciation. After introducing the ELSA application to the treatment group, they received a six-week instruction using this app twice. During this time, the participants in the control group received an ordinary (without application) pronunciation instruction. After the treatment period, the participants in both groups took part in the posttest to check their pronunciation. At the end of the treatment period, the instructor administered the cognitive load questionnaire that was adopted by Yang et al. (2022). The researcher validated the modified questionnaire through a pilot study (N = 20), before conducting the main study. Also, the reliability of the questionnaire was estimated. This internal consistency of the questionnaire calculated through Cronbach's alpha was .905, indicating the high reliability of the cognitive load questionnaire. Later on, in order to consider the participants' attitudes toward using MALL to improve pronunciation three interview questions were asked from the participants. These three interview questions were adopted from Aratusa (2022). All the data regarding the variables of the study were validated by the researcher. Inter-coder reliability (ICR) was used to ensure the reliability of the data. Finally, the collected data was analyzed by SPSS version 26; to analyze the data obtained from the interviews, the thematic analysis was used.

3.4. Design

This mixed-methods research was carried out among EFL students at the intermediate level who were selected based on convenience sampling. In order to uncover the causal relationships between variables, the quasi-experimental design was considered appropriate. The collected data was analyzed by SPSS version 26 software. The variables of the study were pronunciation learning through MALL, learners' attitudes, cognitive load, and performance.

3.5. Data Analysis

The collected quantitative data were analyzed using SPSS Software, version 26. First of all, the Kolmogorov-Smirnov (K-S) test was used to check the normality distribution of the data obtained from the cognitive load questionnaire. Then both descriptive and inferential statistics were utilized. To analyze the data obtained from the questionnaire, descriptive statistical analysis was run to get the mean score, as well as standard deviations of the data sets. In addition, Pearson Correlation was used in order to determine whether there was any statistically significant relationship between the variables of the study. Moreover, through thematic analysis, repeated themes were winnowed and classified. MAXQDA Software was used for qualitative data analysis. The interview responses were analyzed and coded to find common themes. The themes then were analyzed to see if they could be categorized and put into different groups.

4. Results

For this purpose, four research questions along with their hypotheses were formulated. Addressing the first research question: What are Iranian EFL learners' attitudes toward learning pronunciation via MALL programs? the data obtained from interviews were analyzed using thematic analysis. Based on Braun and Clarke's (2006) six phases of thematic analysis, an iterative and reflective data analysis process was conducted.

1. *Familiarizing ourselves with the data.* All the participants were interviewed to express their attitudes towards learning pronunciation via MALL programs.

2. *Generating initial codes.* In this stage, the obtained texts were analyzed carefully to find units of meaning which are statements that mean independently. These statements or meaning units were labeled based on their relationship to potential themes in the data (Braun & Clarke, 2006). Then, these 14 codes were reviewed iteratively so that better codes would emerge. (Table 1)

Table 1.

The Extracted Initial Codes

Before the workshop	
No	Initial code
1	Encouraging learners to learn better
2	Producing hope and happiness among learners
3	Communicating
4	Feeling good about learning more than the traditional method of learning pronounciation
5	Enjoyable learning
6	Practicing that improves learning
7	Prioritizing the MALL devices to personal pronunciations
8	Making a little social anxiety
9	Difficult for weak students
10	Different preferred applications for pronunciation learning
11	Low rate of participation for some
12	Shining role of students
13	Active role of teachers
14	Effectiveness of mobile phone dictionaries

3. *Searching for themes.* This stage contains ordering and connecting the related codes to shape the related themes. First, the related initial codes which could be potentially associated with each other and center around one united theme were identified. In this study, 14 codes could center around 4 main themes.

4. *Reviewing Themes.* In this stage, the codes that shaped one theme were reviewed again to follow a coherent pattern. The emerging themes were not considered final themes until all the codes were analyzed carefully and precisely.

5. *Defining and Naming Themes.* In this stage, it was tried to label the themes. In this part, it should be considered how these themes are connected to the entire data set which is concerned with the research question. In this study, it was always considered that the emerging themes should explain the learners' attitudes toward learning pronunciation via MALL programs. Finally, at the end of this stage, the themes and their related codes were coherently developed which is presented in the below Figures.

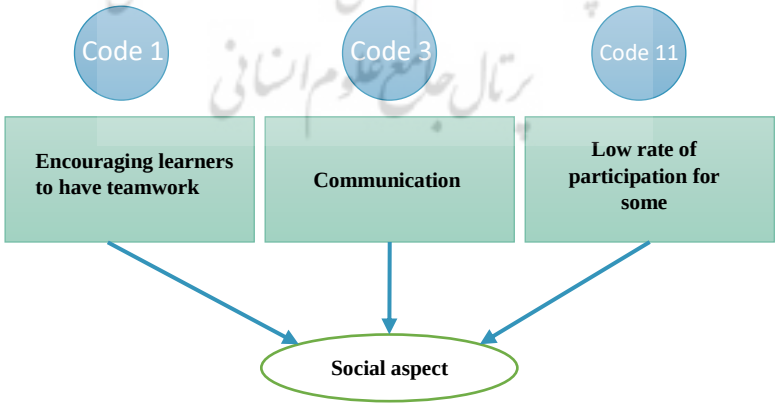

Figure 1.

Theme One: Social Aspect

As seen in Figure 1, comparing code 1, 3 and 11 leads to the theme of social aspect since all the three codes can be categorized under the theme of social aspect.

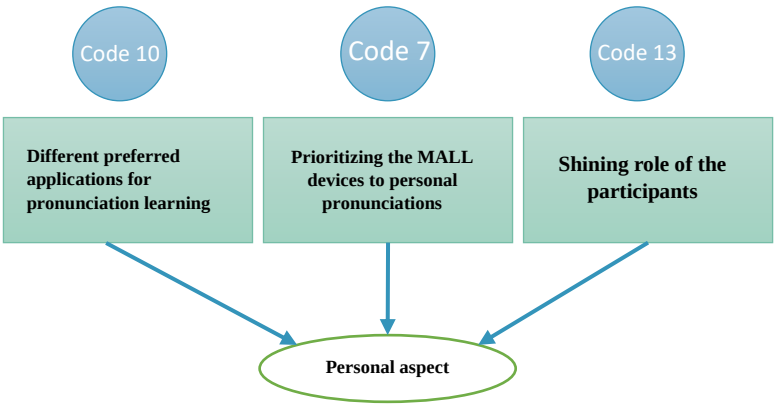

Figure 2.

Theme Two: Personal Aspect

By comparing codes, 7, 10, and 13 it is clear that all of them share the personal aspect together.

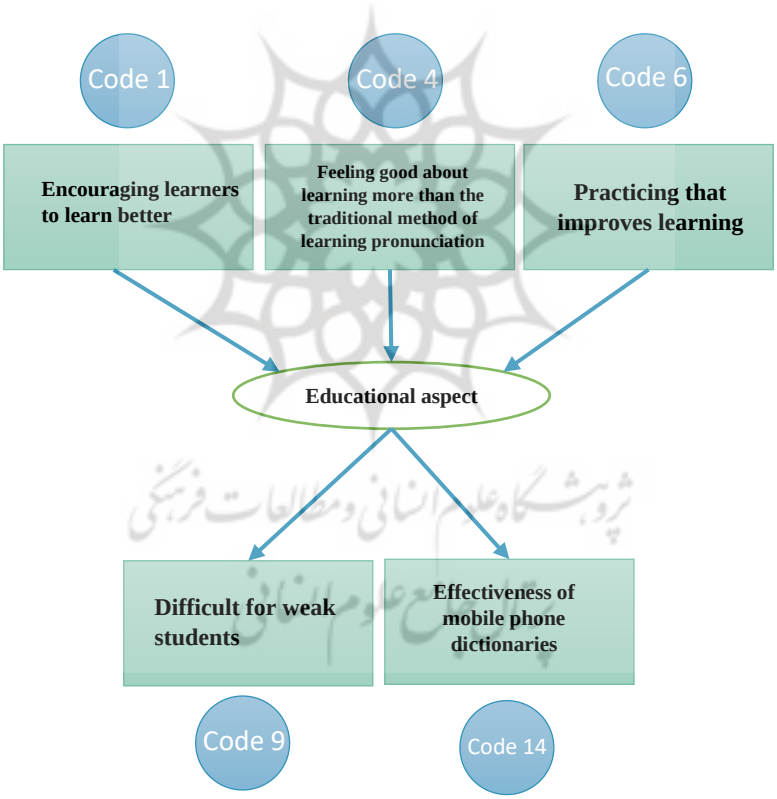

Figure 3.

Theme Three: Educational Aspect

As seen in Figure 3, by comparing codes 1, 4,6,9 and 14, it is evident that participants' ideas can be grouped into educational aspect.

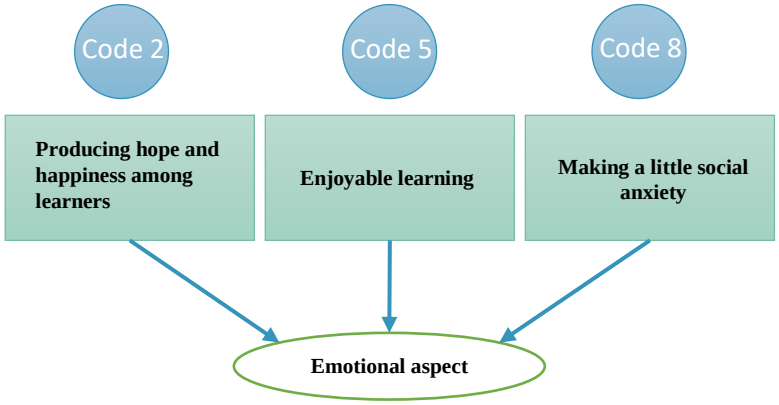

Figure 4.

Theme Four: Emotional Aspect

By comparing codes 2, 5, and 8, it can be concluded that all of them are classified under the emotional aspect.

6. *Producing the Report.* Finally, all the stages of this process of data analysis were reported here especially initial code and emerging themes. In the present study, the emerging themes were:

a) Educational aspect
b) Emotional aspect
c) Personal aspect
d) Social aspect

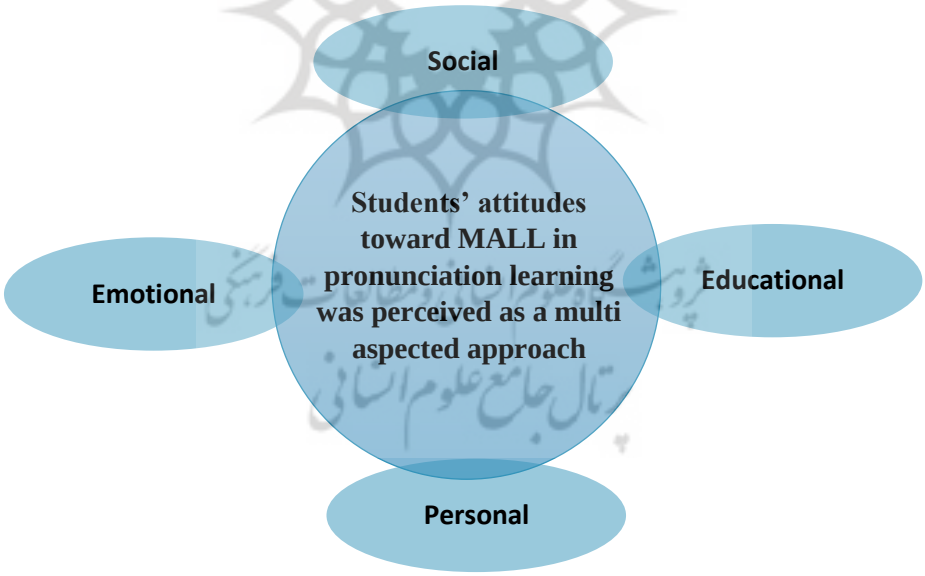

Figure 5.

The Participants' Attitudes toward Learning Pronunciation via MALL Programs in Pronunciation Learning

The following are some sample answers to the interview questions:

"It enhances learning".

"Human is a social creature".

"It is enjoyable".

"It enhances learning a lot".

"It depends on learners' motivation".

"Learners share their ideas about important points".

"Because everyone's perception is different and it could be useful to improve our understanding".

To answer the second research question investigating the effect of pronunciation learning in the MALL environment on the EFL learners' cognitive load, ANCOVA was run. Firstly, Kolmogorov-Smirnov Test was run to check the normal distribution of data. The results are presented in Table 2.

Table 2.

One-Sample Kolmogorov-Smirnov Test

		pre-test cognitive load	post-test cognitive load
N		60	60
Normal Parameters[a,b]	Mean	64.7500	62.8167
	Std. Deviation	5.50385	6.23954
Most Extreme Differences	Absolute	.109	.109
	Positive	.077	.059
	Negative	-.109	-.109
Test Statistic		.109	.109
Asymp. Sig. (2-tailed)		.076[c]	.072[c]

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

The results showed that participants' score on pre- and post-administration of the cognitive load scale were normally distributed (p= .07, .07, p> .05). Table 3. Shows the descriptive statistics of control and experimental groups on post administration of cognitive load scale.

Table 3.

Descriptive Statistics of Control and Experimental Groups on Post Administration of Cognitive Load Scale

Treatment	Mean	Std. Deviation	N
experimental	59.70	6.05	30
control	65.93	4.74	30
Total	62.81	6.23	60

As illustrated in Table 3, the mean of post administration of cognitive load scale of participants who used ELSA application was 59.70 with the standard deviation of 6.05, while, the mean of post-test administration of cognitive load scale of participants who were exposed to traditional instruction was 65.93 with the standard deviation 4.74.

Table 4.

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2195.566[a]	2	1097.783	616.99	.000	.956
Intercept	.563	1	.563	.317	.576	.006
Pre-test cognitive	1612.750	1	1612.750	906.42	.000	.941
Grouping	452.046	1	452.046	254.06	.000	.817
Error	101.417	57	1.779			
Total	239053.00	60				
Corrected Total	2296.983	59				

a. R Squared = .956 (Adjusted R Squared = .954)

To investigate the effectiveness of implementing ELSA application versus conventional instruction on learners' cognitive load One-way between-groups Analysis of Covariance was run. The independent variable was the type of instruction (using ELSA application and conventional instruction), the dependent variable was learners' scores on the post administration of cognitive load scale, and the participants' score on the pre administration of cognitive load scale were used as the covariate in this analysis.

The results revealed that there was statistically significant difference between the control and experimental groups on post-test scores, F(1, 59)= 254.06, p=.00, partial eta squared= .817.

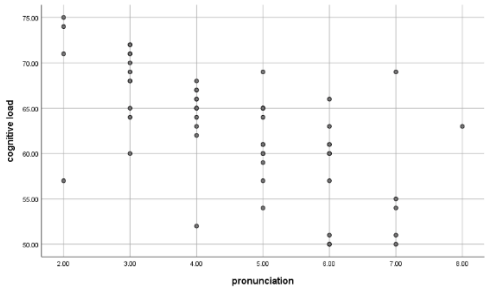

Figure 6.

Control and Experimental Groups on Post Administration of Cognitive Load Scale

To answer the third research question addressing the effect of pronunciation learning in the MALL environment on EFL learner's pronunciation performance, another ANCOVA was run. Firstly, Kolmogorov-Smirnov Test was run to check the normal distribution of data. The results are summarized in table 5.

Table 5.

One-Sample Kolmogorov-Smirnov Test

		pre-test pronunciation	post-test pronunciation
N		60	60
Normal Parameters[a,b]	Mean	3.7333	4.9667
	Std. Deviation	.86834	1.42595
Most Extreme Differences	Absolute	.221	.143
	Positive	.201	.124
	Negative	-.221	-.143
Test Statistic		.221	.143
Asymp. Sig. (2-tailed)		.081[c]	.122[c]

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

The results indicated that learners' scores on the pre and post-tests of pronunciation had normal distribution (p= .08, .12, p> .05). Table 6. provides the descriptive statistics of the control and experimental group's scores on the post-test of pronunciation.

Table 6.

Descriptive Statistics of Control and Experimental Group's Scores on Post-Test of Pronunciation

Treatment	Mean	Std. Deviation	N
Experimental	5.16	1.48	30
Control	4.10	1.21	30
Total	4.63	1.44	60

Table 6. illustrates the results of descriptive statistics for control and experimental group's score on post-test of pronunciation. For the experimental group, the mean was 5.16 with the standard deviation of 1.48, while, for the control group, the mean of was 4.10 with the standard deviation 1.21.

Table 7.

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	19.026[a]	2	9.513	5.169	.009	.154
Intercept	100.892	1	100.892	54.819	.000	.490
prepronun	1.960	1	1.960	1.065	.307	.018
grouping	18.945	1	18.945	10.293	.002	.153
Error	104.907	57	1.840			
Total	1412.000	60				
Corrected Total	123.933	59				

a. R Squared = .154 (Adjusted R Squared = .124)

A one-way between-groups analysis of covariance was calculated to compare the effectiveness of two different interventions of employing ELSA application versus conventional instruction on learners' pronunciation performance. The independent variable was the type of treatment (ELSA application versus conventional instruction), the dependent variable was learners' scores on the post-test administration of pronunciation test, and the participants' score on the pre-test of pronunciation was used as the covariate in this analysis.

The results revealed that there was a statistically significant difference between the control and experimental groups on post-test scores on pronunciation, F(1, 59)= 10.29, p=.00, partial eta squared= .153.

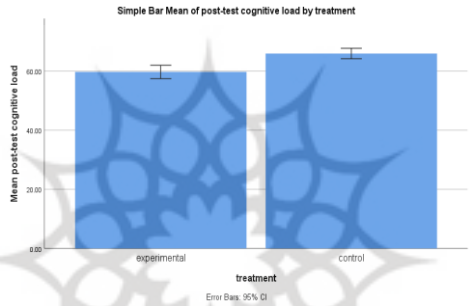

Figure 7.

Control and Experimental Group's Score on Post-Test of Pronunciation

To answer the last research question exploring any significant relationship between EFL learners' cognitive load and pronunciation performance, Pearson correlation was conducted.

Table 8.

Descriptive Statistics of Experimental Group' Score on Pronunciation and Cognitive Load

	Mean	Std. Deviation	N
post-test pronunciation	4.63	1.449	30
post-test cognitive load	62.81	6.239	30

Table 9.

Correlations between Learners' Cognitive Load and Pronunciation Performance

		post-test cognitive load
post-test pronunciation	Pearson Correlation	-.624**
	Sig. (2-tailed)	.000
	N	60

**. Correlation is significant at the 0.01 level (2-tailed).

The results showed that there is a significant negative correlation between EFL learners' cognitive load and pronunciation performance (r= -.62, p< .05)

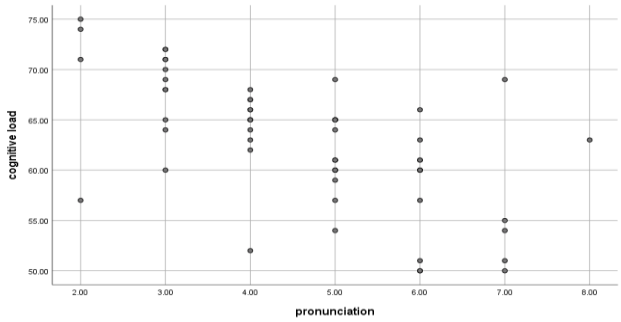

Figure 8.

Relationship between EFL Learners' Cognitive Load and Pronunciation Performance

5. Discussion

In this study, we investigated the effects of Mobile-Assisted Language Learning (MALL) on Iranian English as a Foreign Language (EFL) learners, focusing on their attitudes, cognitive load, and performance in pronunciation learning. The study aimed to explore key aspects of MALL's role in language learning by addressing several essential questions. First, we sought to understand Iranian EFL learners' attitudes toward learning pronunciation through MALL programs. Given the growing integration of technology in educational settings, it is important to explore whether MALL can positively influence learners' perceptions of pronunciation instruction. Second, the study examined the effect of MALL on learners' cognitive load, which is crucial for understanding the mental effort required during the learning process.

Third, we aimed to investigate how pronunciation learning in the MALL environment impacts learners' overall performance, specifically in terms of their ability to improve pronunciation skills. Finally, we explored the potential relationship between learners' cognitive load and performance in the MALL context, as this relationship could offer valuable insights into how cognitive factors influence language acquisition in technology-driven environments. The following discussion will delve into the findings related to each of these questions, providing a deeper understanding of the potential benefits and challenges of incorporating MALL into pronunciation learning for Iranian EFL learners.

The analysis of the data revealed several key findings related to the research questions. First, regarding Iranian EFL learners' attitudes toward learning pronunciation via MALL programs, the results indicated that participants expressed positive attitudes, which were categorized into four main areas: social, emotional, personal, and educational reasons. Learners appreciated the opportunity for social interaction, the emotional satisfaction it provided, the personal empowerment through self-paced learning, and the educational benefits, all contributing to their overall positive outlook on MALL for pronunciation practice.

In relation to the second question about the effect of pronunciation learning in the MALL environment on EFL learners' cognitive load, the data revealed that learning pronunciation through MALL significantly reduced cognitive load. Participants reported a more manageable and less overwhelming learning experience, which allowed them to focus their mental energy on mastering pronunciation, rather than struggling with excessive cognitive strain. Addressing the third question regarding the impact of pronunciation learning in the MALL context on EFL learners' performance, the findings showed a notable improvement in pronunciation performance among learners in the MALL environment. The use of mobile-assisted learning tools was associated with better pronunciation outcomes, indicating that MALL was effective in enhancing learners' ability to produce accurate pronunciation.

Finally, in regard to the relationship between cognitive load and performance in the MALL context, a negative correlation was found between learners' cognitive load and their pronunciation performance. This suggests that as learners' cognitive load decreased, their pronunciation performance improved, emphasizing the importance of reducing mental strain to achieve better learning outcomes.

Our study aligns with previous research on the use of Mobile-Assisted Language Learning (MALL) for pronunciation instruction, providing further evidence of its positive impact. Similar to Aratusa (2022), our study found that participants held positive attitudes toward using MALL for pronunciation learning. We identified social, emotional, personal, and educational reasons as key factors influencing these positive perceptions. These findings are consistent with Miqawati (2020), who highlighted MALL's effectiveness in improving pronunciation, boosting participation, and fostering positive attitudes. Furthermore, our study supports the conclusions of Haryadi and Aprianoto (2020), who observed that mobile applications increased student participation and self-learning in pronunciation. The emotional and personal factors that influenced students' preferences in their study were similarly important in our findings. Moreover, our study is consistent with the findings of Ahmed (2022), who demonstrated that mobile applications like Duolingo and WhatsApp significantly improved pronunciation accuracy, fluency, and speaking performance. In our study, participants in the MALL environment showed notable improvements in pronunciation performance, further supporting the effectiveness of mobile-assisted learning. These results align with the third research question of our study, which found that MALL positively impacted pronunciation performance.

Our findings also echo the work of Abduh (2019), who reported significant effects of mobile phone use on pronunciation improvement. In both studies, participants in the experimental groups that used MALL tools outperformed those in the control groups, further confirming that MALL technologies can enhance pronunciation skills. The theoretical underpinnings of MALL, as outlined by Norbrook and Scott (2003) and McNicol (2004), also align with the results of our study. The portability and immediacy of MALL practices enable learners to engage with content flexibly, which, as demonstrated by Chang (2018), can lead to improved language learning outcomes. Our study supports this by showing that MALL provides a convenient and accessible platform for learners to practice pronunciation anytime and anywhere, ultimately contributing to better performance.

Finally, the results of Chang (2018) regarding cognitive load and performance align with our findings. We observed a negative significant relationship between cognitive load and pronunciation performance in the MALL context, reinforcing the idea that MALL reduces cognitive load and improves learning outcomes, as also seen in their experimental group. In summary, the findings from our study regarding the positive effects of MALL on pronunciation, students' attitudes, cognitive load, and performance are consistent with and further substantiate the results from existing literature in the field.

6. Conclusion

This study aimed to explore the effects of Mobile-Assisted Language Learning (MALL) on EFL learners' attitudes, cognitive load, and performance in pronunciation learning. The findings provide strong evidence of the positive impact of MALL on pronunciation acquisition, highlighting its potential as a valuable tool in language education. While face-to-face classes continue to hold significant importance in fostering serious engagement among learners, mobile learning classes have garnered higher satisfaction rates, largely due to the flexibility and convenience MALL offers. The ability to learn anytime and anywhere allows students to extend their practice beyond the classroom, making it particularly advantageous in the context of language learning where practice time is often limited.

Our analysis revealed that learners' attitudes toward pronunciation learning via MALL could be classified into social, emotional, personal, and educational factors, which positively influenced their experiences. Additionally, participants demonstrated improved pronunciation performance within the MALL environment, further validating the efficacy of mobile learning tools in enhancing language skills. Furthermore, the study found a negative correlation between cognitive load and pronunciation performance, suggesting that MALL not only alleviates cognitive load but also contributes to better learning outcomes.

From a pedagogical standpoint, the results emphasize the importance of incorporating MALL into language learning to increase motivation and engagement. The use of mobile applications can effectively capture students' attention, making learning enjoyable and accessible. Teachers can leverage MALL to create dynamic, learner-centered environments where students have control over their learning pace, thus fostering independent and self-directed learning. Moreover, by enabling students to engage with the material outside of class, MALL provides an opportunity for continuous learning and practice, which is crucial for language development.

In conclusion, the findings of this study demonstrate that MALL offers a promising avenue for improving pronunciation skills among EFL learners. By addressing both cognitive and emotional aspects of learning, MALL not only enhances learners' performance but also enriches their overall language learning experience. Therefore, incorporating mobile learning into pronunciation instruction holds significant potential for creating more flexible, effective, and engaging learning environments.

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