



## On the Impact of Using Mobile Applications on Reading Comprehension Achievement and Attitude of Engineering ESP Student

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### Abstract

The purpose of this study was to investigate the impact of mobile applications on the reading comprehension achievement and attitude of Iranian engineering students. To achieve this goal, a group of freshman and sophomore students of chemical engineering, materials science and metallurgy engineering from Semnan University in Iran were selected to participate in this study. The study utilized a pretest and posttest multiple-choice reading comprehension assessment for the experimental and control groups, as well as using two mobile applications over a six-week period for the experimental group. One-way ANCOVA ( $F(1, 57) = 8.35, p = 0.005$ ) revealed that mobile applications boosts reading comprehension achievement of Iranian ESP engineering students. Additionally, a positive significant relationship ( $r(68) = 0.31, p = 0.01$ ) was found between the amount of time spent using the applications and the participants' reading comprehension achievement. The study highlights the potential of mobile-based learning and applications to support English language learning and teaching. As a result, this research could serve as a catalyst for English language education policymakers and curriculum designers to encourage teachers and learners to incorporate new educational tools and allocate sufficient class time for technology-based instruction.

**Keywords:** Iranian engineering students, mobile applications, mobile learning, reading comprehension achievement

### 1. Introduction

The fast evolution of mobile technology has dramatically transformed the way we receive, share, and utilize information. With unprecedented rates of adoption, mobile devices have become more affordable and accessible than ever before, as evidenced by studies led by Hao et al. (2017) and Kaliisa et al. (2017) indicating a positive correlation between mobile industry expansion and personal ownership



in both developing and developed countries. The portability and context-sensitivity of these devices, coupled with their instant connectivity (Churchill & Churchill, 2008; Sharples, 2000), have led to an increasingly interconnected world.

The Covid-19 pandemic was the critical challenge in the education system at the end of 2019. Then there was a shift from traditional classroom education style to electronic one specifically through mobile learning. Despite the many advantages of mobile devices, such as their ubiquitous nature, there are also limitations such as small screen size, lower display quality (Albers & Kim, 2002), and limited battery life.

Mobile learning (m-learning), a relatively new academic enterprise, has emerged as an innovative and convenient method of accessing educational materials at any time and from anywhere via the internet and mobile technologies (Lan & Sie, 2010). This concept, linking the previously disparate areas of "mobile" and "learning," has been the subject of numerous studies, with somewhat varying interpretations and characteristics (Frohberg et al., 2009; Kukulska-Hulme et al., 2009). According to Bernacki et al. (2020), mobile learning involves the incorporation of personal electronic gadgets into the teaching and learning process, connecting learners with media, educators, experts, peers, and the larger world across multiple contexts. Also, it is strongly supported by the rapid development of mobile technologies including personal electronic devices e.g., smart phones and tablets and wireless services e.g., Wifi and 4G/5G telecommunication networks (Chen, 2024). M-learning provides a unique opportunity to break away from traditional classroom instruction and learn in a different environment while maintaining communication via a network (Gheytasi et al., 2015).

Considering the many features of mobile gadgets, policymakers, educators, and researchers are exploring the potential of mobile learning in developing innovative educational methods and pushed them to innovate pedagogies that have disrupted traditional teaching methods (Jie & Sunze, 2021). For English as Foreign Language (EFL) learners, this can be a particularly efficient and effective learning context.

## 2. Literature Review

### 2.1. Technology and Education

Technology and education are two crucial aspects of our modern world. As we progress through the 21st century, it is clear that technological advances are becoming increasingly essential in our daily routines. From the internet to digital devices and mobile tools, technology has transformed the way we live and work (Silva et al., 2017). The rise of mobile gadgets has outpaced that of laptops and desktops, making mobile devices the new personal computers. Mobile devices have become increasingly sophisticated and powerful in recent years (Ali, 2013).

As the number of learners using digital devices such as mobile devices, notebooks, digital assistants, tablets, and MP3 players continues to grow, educators are increasingly considering the role mobile technology plays in assisting teaching and learning both in and out of the classroom (Cheon et al., 2012; Uzunboylu & Ozdamli, 2011). Mobile technology has grown into an important portion of the teaching and learning process (Cavus & Ibrahim, 2009; Hwang et al. 2011; Lai & Hwang, 2015). For example, mobile phones are now being used to enrich foreign language education, such as reading, vocabulary, speaking, listening, and grammar, in both formal and informal settings (Stockwell, 2010; Zhang et al. 2011; Rueckert et al. 2012; Demouy & Kukulska-Hulme, 2010). However, while some

researchers agree with the use of cell phones in education (Cakir, 2015; Nalliveetil & Alenazi, 2016), many teachers and curriculum designers are hesitant to allow students to use their personal digital devices in the classroom (Van Praag & Sanchez, 2015; Woodman, 2014).

Despite the various positive and negative perspectives on the use of mobile gadgets in education, the application of mobile, handheld, and portable devices is gradually increasing, and the use of mobile technologies in the learning process has garnered significant interest in educators, curriculum designers, and researchers in recent years (Hwang & Wu, 2014). Also, mobile technology has brought forth mobile learning with the surge of distance learning (Jie & Sunze, 2021). As we move forward, it is important to continue exploring the possibilities of technology in education, while also being mindful of the challenges that come with it. By doing so, we can ensure that we are maximizing the potential of technology to enhance and improve education for all learners.

## 2.2. Mobile Learning

Mobile learning, or m-learning, has become a prevalent form of education in recent years, as it emphasizes on the flexibility and mobility of learners. The amount of global mobile users grows sharply nearly to 7.26 billion, benefitting from the affordable advantage of modern mobile technologies (Chen, 2024). M-learning combines the previously separate concepts of "learning" and "mobile" to create an interactive and engaging learning environment (Wai et al., 2018; Zydney & Warner, 2016). By leveraging the ubiquity of mobile and portable technologies as well as the internet, m-learning offers learners access to educational materials anytime and anywhere (Lan & Sie, 2010). In 2020, the irreplaceable role of mobile learning for education was underlined by the world-wide lockdown measures to handle the global COVID-19 pandemic (Chen, 2024).

Various studies, including those conducted by Tekale and Jadhav (2020) and Temirkulova (2023), have identified several benefits to m-learning. These take account of cost-effectiveness, the capacity to create and deliver multimedia content, continuous educational support, lower training fees, and the potential for increased motivation and engagement among learners. Moreover, m-learning can enhance literacy levels, participation, and numeracy among young learners.

However, despite its advantages, some students are still hesitant and worried about its negative outcomes to use mobile devices for purpose of education as a result of several limitations. These limitations can be classified into three categories: technical, pedagogical, and psychological (Viberg & Gronlund, 2013). Technical impediments mean hardware deficiencies, such as inadequate memory, small screen size, slow network speed, and lack of compatibility and standardization (Lowenthal, 2010; Park, 2011; Stockwell, 2010; Viberg & Gronlund, 2013; Wang & Higgins, 2006; Wang et al., 2009). Pedagogical restrictions include the need for extra support, interruptions to class progress, and distraction of students (Corbeil & Valdes-Corbeil, 2007; Wang et al., 2009). Lastly, psychological limitations relate to the shift in learning habits from traditional face-to-face instruction to m-learning and the tendency of learners make use of mobile devices for non-educational activities, such as checking social media, sending multimedia messages, and listening to music (Park, 2011; Wang et al., 2009).

By and large, m-learning offers many benefits, but it is essential to address its limitations to maximize its potential. With careful consideration of these challenges and the implementation of effective solutions, m-learning can offer an innovative and effective approach to education.

### **2.3. Mobile Applications**

Mobile applications have had an impressive boom in recent years and have encompassed various aspects of our life, and teaching and learning via them is not an exception (Cruz et al., 2023). M-learning has turned into an increasingly famous mode of learning and accessing instructional resources, as well as staying connected with colleagues. With the rise of mobile application usage, it is important to question whether current mobile English language learning applications are efficient and practical tools for language learners and teachers alike.

To determine the most suitable application of m-learning, several studies were conducted in support of English language teaching. According to Hussin et al. (2012), good and practical m-learning applications must possess certain characteristics, such as an introduction to key concepts and terms, a guide for improving understanding through demonstration, illustrations, and examples, and exercises for mastering skills through exploration, simulation, and drill-practice. Additionally, these applications should assess achievement through testing.

Hussin et al. (2012) also noted that good mobile applications should provide individualized instruction through structured or unstructured lessons, cater to the learning process, and offer interactive or bi-directional learning features such as feedback and progress reports.

Another feature to consider in designing practical learning apps is usability, as pointed out by Wei et al. (2015). Usability is the extent to which users are able to succeed in their specified goal, and poor usability results in poor user interaction. Brinck et al. (2002) defined usability as the degree to which users can perform required tasks and added another attribute: functionality. Nielsen (2000) views usability as the key attribute of user interface and a multidimensional construct encompassing learnability, memorability, efficiency, errors, and satisfaction. Sharples et al. (2007) added efficiency and effectiveness to the list of attributes, while Shitkova et al. (2015) view usability as a guideline for designers and developers to create usable and practical applications that increase user acceptance.

### **2.4. M-learning in Iran (A Brief Review of the Previous Studies)**

M-learning has gained significant approval and attention from curriculum designers and educational researchers in Iran's Mobile Assisted Language Learning (MALL). Although there is a lack of large-scale research to identify the potential benefits of m-learning in English language teaching and learning in Iran, several authors have investigated the use of mobile gadgets for learning basic and sub-skills of EFL, such as reading comprehension, listening, speaking, vocabulary, grammar, and different learning strategies. The study results of Fotouhi-Ghazvini et al. (2009) suggest that the application of MALL games can increase the English language proficiency level of Iranian EFL learners. Khabiri and Khatibi (2013) noted that most Iranian EFL learners consider mobile gadgets crucial learning tools, using them for vocabulary learning and social networking via SMS.

Baleghzadeh and Oladrostam (2010) claim that using m-learning activities can effectively enhance the grammatical accuracy of Iranian EFL students. Other researches done by Alavinia and Qoitassi (2013), Khodashenas and Amouzegar (2014) suggest that Iranian EFL students have a great attitude towards expanding their vocabulary knowledge through using installed dictionaries on their mobile gadgets. Azar and Nassiri (2014) suggest that mobile gadgets can be considered efficient tools for Iranian EFL students to gain more proficiency in listening skill. Teymouri and Hosseini (2013) found that enhancing the usage of MALL activities leads to improvement in the usage of learning strategies

by Iranian EFL students. Mahmoudi and Afraz (2014) claimed that providing speaking lesson plans via mobile gadgets can enhance the fluency, proficiency, and competence level of EFL students in speaking skill. Finally, Gheytsi et al. (2015) explored the impact of smartphones on the achievement of EFL students in reading comprehension, further highlighting the potential benefits of mobile gadgets in English education in Iran.

Many scholars and researchers in Iran have shown a keen interest in investigating the impact of using cell phones and learning applications in the educational environment, including Azar and Nassiri (2014), Baleghizadeh and Oladrostam (2010), Gheytsi et al. (2015), and Khabiri and Khatibi (2013). The results of these studies suggest that integrating mobile gadgets in English educational settings is a successful method in Iran's context. Furthermore, they emphasize the positive attitudes and eagerness of both teachers and learners to use these devices to improve English language basic and sub-skills.

## 2.5. Reading Comprehension

Reading is one of the most important forms of human communication and one of the most complex domains of language use (Ostojić. 2023). The ability to read and comprehend a second language (L2) is an essential skill for language learners, as it leads to independence in the language learning process (Carrell & Grabe, 2002). Reading plays a significant role in the development of learners' English language proficiency by enhancing their basic and sub-skills (Al-Seghayer, 2017; Arena & Jefferson, 2008; Halic et al., 2010; Luu & Nguyen, 2010; Peterson, 2012; Smidt & Hegelheimer, 2004; Yoon, 2008). As professionals, it is crucial to recognize the importance of improving this skill to facilitate learners' linguistic growth.

## 2.6. Extensive and Intensive Reading

As per Harmer's (2007) categorization, reading can be divided into two types: intensive and extensive. It's crucial to differentiate between the two. Intensive reading refers to a more detailed concentration on the structure and construction of a reading text, usually in a classroom setting. Learners may be required to examine novels, websites, newspapers, and book chapters more closely, dissecting details of significance, analyzing grammatical structures, and retaining information to answer relevant questions. Conversely, extensive reading is a reading style that learners can pursue outside of the classroom. Grabe and Stoller (2002) define extensive reading as a pedagogy that allows language learners to read what they want, based on their interests, with enjoyment, comprehension, and seeking information as the aim. Evidence in English language learning and teaching indicates that learners can acquire vocabulary and grammar through extensive reading (Krashen, 1982).

## 2.7. Processes in Reading Comprehension

The reading comprehension ability is a complex skill that varies based on goals, tasks, and language knowledge. Regular reading procedures are stimulated as we read, according to Schmitt & Rodgers (2020). Skilled reading is divided into higher-level and lower-level processes. Higher-level processes focus on comprehension procedures that emphasize the reader's inferencing abilities and background knowledge. By establishing reading goals, making various types of inferences, combining reading strategies based on learners' needs, monitoring comprehension, drawing upon background knowledge, adjusting goals as needed, and forming attitudes about the author and text, readers enhance their understanding of the main ideas of the text and interpret them. Background knowledge plays a supporting role and aids in predicting the text's discourse organization and disambiguating word-level

and clausal meanings as new information is integrated into the text model (Grabe & Stoller, 2020). Lower-level processes are more skills-oriented and represent the more automatic linguistic processes, according to Schmitt and Rodgers (2020). The most basic requirement for fluency in reading is automatic and speedy word recognition in lower-level reading comprehension (Schwanenflugel & Knapp, 2016). The readers who belong to the lower-level anticipated to recognize each word in about 240 milliseconds on average, (Pressley, 2006).

## **2.8. Reading Comprehension and Technology**

Technology is a valuable tool that can assist EFL students in achieving better reading comprehension. Over the past decade, many scholars have explored the impact of technology integration in the classroom and its effect on students' reading skills, with positive correlations consistently found (e.g., Blok et al., 2002; Cheung & Slavin, 2012; Slavin et al., 2009).

Various researchers have investigated the use of technology in the classroom from different perspectives. For instance, Boekaerts and Corno (2005) and Zimmerman and Tsikalas (2005) have focused on computer-based learning contexts that follow scaffolding rules to guide students towards greater autonomy and control over their learning. Furthermore, students can work independently with computers and enjoy learning on their own and with peers. Multimedia content can also reinforce students' motivation to read various texts (Lysenko & Abrami, 2014), making motivation one of the key benefits of technology-based reading instruction. As Lee (2000) notes, mobile gadgets and personal computers can enhance students' sense of self-sufficiency, further strengthening their motivation. Additionally, integrating computers into reading instruction can reduce the complications that teachers face when attempting to implement complex and multiple reading strategies in the classroom (Lysenko & Abrami, 2014), allowing them to focus their attention and effort more effectively on the learning process (Lynch et al., 2000; Mathes et al., 2001).

Huang's (2014) study compared the effects of modern computer-based reading and traditional paper-based instruction among EFL university students and found that the online reading group demonstrated a higher level of reading comprehension compared to the traditional paper-based group.

Furthermore, as the number of international projects in various disciplines continues to increase (Riemer, 2007), particularly in the engineering fields, it has become necessary for undergraduate engineering students to have a high level of English language proficiency. This high proficiency helps students compete in the working world and future careers, as English is a common language worldwide. The need for English proficiency among engineering students has received significant attention from scholars, with numerous research papers and reports focusing on various aspects of English language education for engineering students. For instance, Dos Santos (2019) evaluated the professional needs of engineering students using social media learning platforms and visual-only video as a teaching tool, while Tsai and Chang (2014) attempted to improve reading skills among engineering students through online reading comprehension strategy instruction.

Based on these studies, it is clear that integrating technology into the English language educational context has high potential for enhancing reading comprehension achievement among ESP students, particularly those in the engineering field. However, there is a lack of research on how mobile gadgets such as laptops and cell phones can improve reading comprehension achievement among ESP engineering students worldwide, and no large-scale studies have been conducted to determine the

potential advantages of m-learning in the Iranian English language learning context. Therefore, the current study aims to investigate the influence of using mobile applications on the reading comprehension achievement of Iranian ESP engineering students.

### 3. Research Questions

The goal of this study was to investigate the influence of using mobile applications on reading comprehension achievement of engineering ESP students and their attitudes towards it. To achieve the purpose of this study, two research questions were addressed:

1. Does using mobile applications affect reading comprehension achievement of Iranian ESP engineering students?
2. Is there any significant relationship between the amount of time using the applications and participants' achievement in reading comprehension?

### 4. Method

#### 4.1. Design of the Study

The quasi-experimental design was adopted in the research as it does not contain the component of random assignment to treatment or control. This design characteristically let the investigator control the assignment to the treatment condition, nevertheless using some standard other than random assignment. This study was concerned with two variables: using mobile applications as the independent variable, and chemical engineering reading comprehension achievement as the dependent variable. There was one experimental group which received reading instruction through mobile applications, and one control group which experienced reading instruction using conventional way. After experiencing the treatments, both groups gave the posttest of reading comprehension (Hatch & Farhady 1982, p. 20).

#### 4.2. Participants

This study was conducted with 70 freshman and sophomore students, comprising 41(58.5%) male and 29(41.5%) female, who had an average age of 18.9 and were pursuing a B.A. degree in either chemical engineering (32) or materials science and metallurgy engineering (38) at Semnan University, Semnan, Iran. All participants were native Farsi (Persian) speakers. They were divided into two groups based on their placement test scores. The Elementary and Pre-intermediate group (51), with scores below 30, used the "Reading Comprehension" application, while the Intermediate group (19), with scores above 30, used the "Reading Comprehension-GRE Test Prep & Practice" application. This study was conducted professionally with a focus on improving the students' reading comprehension skills.

#### 4.3. Instruments

In order to effectively answer the two research questions, we employed a placement test, Solution Placement Test, and two mobile applications, namely "Reading Comprehension-GRE Test Prep & Practice" and "Reading Comprehension". To ensure consistency in the proficiency level of participants in each group, we utilized the Solutions Placement Test developed by Oxford University Press (2011). This test assessed participants' vocabulary knowledge and grammar level, ranging from elementary to intermediate, with 50 multiple-choice questions. Additionally, the test included a reading passage with ten graded comprehension questions, as well as an optional writing task to evaluate students' language production abilities. Participants completed all three parts of the test within

approximately 50 minutes, and the pretest and posttest of reading comprehension showed a reliability of 0.87 and 0.80, respectively, based on KR-21.

We also used two mobile applications as a second instrument. The “Reading Comprehension-GRE Test Prep & Practice” app was designed for intermediate English language proficiency level engineering students, featuring over 200 passages, quick and short tests, detailed test analysis, free download, and offline access. On the other hand, the “Reading Comprehension” app was created for elementary and pre-intermediate engineering students, with a focus on improving reading skills and allowing learners to study at their own pace and convenience. Users can test their skills in the two separate sections of vocabulary and reading comprehension, and check their answers for accuracy. Both applications are available on Google Play Store and can be downloaded on Android versions 2.0.4 and higher.

Overall, the combination of the placement test and mobile applications provides a comprehensive approach to improving reading comprehension skills for English language learners in engineering.

#### **4.4. Data Collection Procedure**

The present study consisted of three phases, each meticulously designed to obtain accurate and significant results. In the first phase, a comprehensive workshop was conducted to elucidate the study's objectives, participants' roles, application usage guidelines, and pretest exam administration procedures. The importance of English language reading proficiency was also highlighted, especially for engineering students, emphasizing its critical role in accessing original sources, ensuring educational success and future career prospects.

During the second phase, participants were divided into two groups based on their placement test scores. Each group worked with a designated application for six weeks, diligently practicing and submitting weekly reports on their progress. Moreover, consultation sessions were held twice during the study to address participants' queries, primarily related to application download and installation, text comprehension, and report writing.

Finally, in the third phase, the same pretest exam was administered as a posttest, and the results were analyzed by comparing both scores. The study's findings were conclusive and informative, providing valuable insights into the efficacy of mobile applications in enhancing English language reading skills among engineering students.

#### **4.5. Data Analysis**

To analyze the data to answer the first research question which asked about the impact of employing mobile applications on reading comprehension achievement, one-way analysis of covariance (ANCOVA) was performed through SPSS Software Version 25. Before performing ANCOVA, the assumptions of linearity, homogeneity of variances, and homogeneity of regression slopes were checked. Moreover, to explore the relationship between the amount of time using the applications and participants' achievement in reading comprehension, Pearson product moment correlation coefficient was used.

## 5. Results

### 5.1. Addressing Research Question One

The purpose of the first research question of the current study was to find out if using mobile applications affect reading comprehension achievement of Iranian ESP engineering students or not. To investigate this research question, analysis of covariance was applied. The scores on the pretest are dealt as a covariate to control for pre-existing differences between the groups. ANCOVA assumes that the following assumptions are met: no influence of treatment on covariate measurement, reliability of covariates, no strong correlations among covariates, normality, linear relationship between dependent variable and covariate, and homogeneity of regression slopes (Tabachnick & Fidell, 2013). Since the covariates were measured prior to the treatment, they could not be influenced by the treatment. Therefore, this assumption was not violated. In addition, there was only one covariate in each ANCOVA analysis. Hence, the assumption of correlation among covariates was not applicable.

To check the assumption of the reliability of covariates, Cronbach's Alpha was checked. Results showed that the covariate was measured reliably ( $r = 0.853$ ).

Table 1 summarizes the skewness and kurtosis and their ratios over the standard errors for engineering reading comprehension scores on both groups and on pretest and posttest. Field (2009) believes that the ratios of skewness and kurtosis over their respective standard errors are analogous to standardized scores (z-scores) that can be compared against the critical values of  $\pm 1.96$  at 0.05 levels. As all ratios were within the ranges of  $\pm 1.96$ , it was concluded that the assumption of normality was fulfilled.

**Table 1**

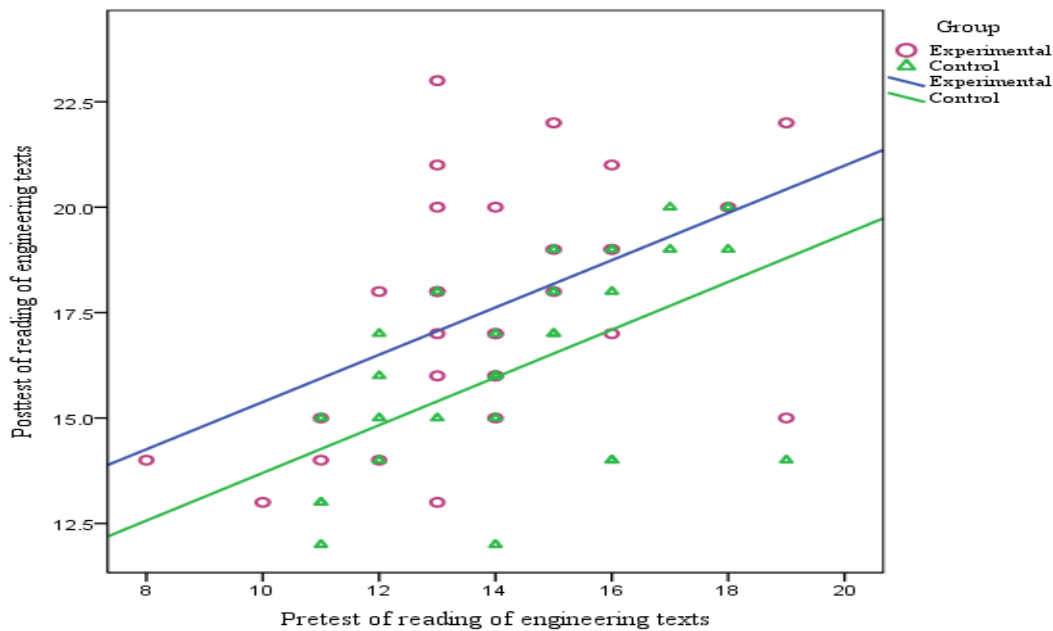
*Skewness and Kurtosis Test of Normality for Engineering Reading Comprehension Scores*

Time	Group	N	Skewness	Std. Error	Skewness Ratio	Kurtosis	Std. Error	Kurtosis Ratio
Pretest	Experimental	30	0.106	0.423	0.251	0.741	0.827	0.896
	Control	30	0.22	0.423	0.520	-0.675	0.827	-0.0816
Posttest	Experimental	30	0.131	0.423	0.310	-0.845	0.827	-1.022
	Control	30	-0.044	0.423	-0.104	-0.878	0.827	-1.062

The assumptions of linearity of the relationship between dependent variable and the covariate, and the homogeneity of regression slopes were also checked. Figure 1 examines the linearity assumption, which assumes that the relationship between the dependent variable (posttest reading comprehension of engineering texts) and the covariate (pretest reading comprehension of engineering texts) is a linear one. The scatterplot shows that the three lines are straight, thus it can be concluded that the requirement of linearity was not violated.

**Figure 1**

*Scatter Plot of Pretest and Posttest of Reading Comprehension of Engineering Texts*



As see in Table 2, the significant value associated with Levene’s test (0.27) was larger than the selected significant level (0.05) implying that the homogeneity of variance assumption was met for reading comprehension scores in the two groups.

**Table 2**

*Levene's Test of Equality of Error of Engineering Reading Comprehension Scores by Group*

Levene Statistic	df1	df2	Sig.
1.114	1	58	0.274

Homogeneity of regression slopes was the next assumption to be checked. As manifested in Table 3, the results showed that the significance level of the interaction (Group\*Pretest) between group and the pretest of total reading comprehension of engineering texts was above 0.05,  $F(1, 56) = 0.11, p = 0.86, p > 0.05$ , and, therefore, not statistically significant. This means that the pretest and posttest of reading comprehension scores in the two groups enjoy the assumption of homogeneity of regression slopes.

**Table 3**

*Homogeneity of Regression Slopes for Reading Comprehension of Engineering Texts*

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	122.344	3	43.777	8.808	0.000	0.321
Intercept	123.227	1	122.228	24.593	0.000	0.305
Group*Pretest	0.002	1	0.002	0.115	0.861	0.000
Error	278.319	56	4.970			
Total	16447.000	60				

Corrected Total            501.350            59

As all assumptions were met, the researchers decided to perform one-way ANCOVA. Table 4 indicates that the mean of reading comprehension of engineering texts in the experimental group ( $M = 13.87$ ,  $SD = 2.40$ ) and control group ( $M = 14.27$ ,  $SD = 2.22$ ) are not far from each other on the pretest; however, on the posttest, the mean of reading comprehension in the experimental group ( $M = 17.54$ ,  $SD = 2.76$ ) is much higher than the mean in the control group ( $M = 16.10$ ,  $SD = 2.27$ ).

**Table 4**

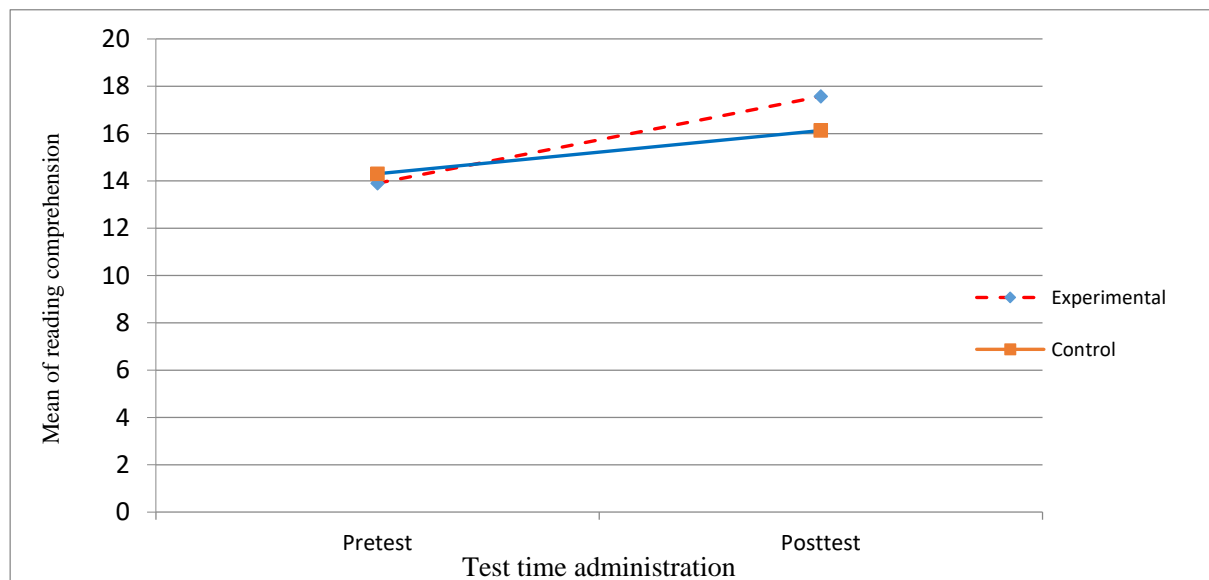
*Descriptive Statistics of Engineering Reading Comprehension Scores*

Test	Group	N	Mean	SD	SEM
Pretest	Experimental	30	13.87	2.40	0.441
	Control	30	14.27	2.22	0.412
Posttest	Experimental	30	17.54	2.76	0.509
	Control	30	16.10	2.27	0.423

A Line Chart (Figure 2) was prepared to demonstrate the results of both pretest and posttest for both groups in terms of reading comprehension.

**Figure 2**

*Line Chart for Two Groups' Means of Reading Comprehension of Engineering Texts (Pretest & posttest)*



As it's crystal clear from the Line Chart, the means of reading comprehension in the experimental and control groups are nearly at the same level on the pretest, though, on the posttest, the mean for the control group is noticeably higher than the experimental group.

After adjusting for the reading comprehension scores on the pretest, there was a significant difference among the reading comprehension means of the two groups on the posttest,  $F(1, 57) = 8.35$ ,

$p = 0.005$ ,  $p < 0.01$ , partial eta squared = 0.11, (Table 5). Thus it can be concluded that employing mobile applications improves reading comprehension achievement of Iranian ESP engineering students.

Besides, according to the results shown in Table 5, there was a strong relationship between the pre-intervention and post-intervention scores on the total reading comprehension ( $F(1, 57) = 19.87$ ,  $p = 0.000$ ,  $p < 0.01$ ). This means the reading comprehension scores gained on the pretest affect the reading comprehension scores gained on the posttest. Additionally, Table 5 shows that the partial eta squared (effect size) value is 0.22.

**Table 5**

*Tests of Between-Subjects Effects on Reading Comprehension of Engineering Texts*

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	134.325	2	65.632	13.448	0.000	0.301
Intercept	123.318	1	123.307	25.255	0.000	0.285
Pretest	102.512	1	100.512	19.866	0.000	0.221
Group	40.953	1	40.953	8.354	0.005	0.115
Error	267.322	57	4.883			
Total	17344.000	60				
Corrected Total	406.650	59				

## 5.2. Addressing Research Question Two

Pearson correlation was run to explore any significant relationship between the amount of time using the applications and participants' achievement in reading comprehension in order to probe the third research question. The results displayed in Table 6 ( $r(68) = 0.308$ ) representing a moderate effect size,  $p = 0.010$ ) indicated that there was a substantial relationship between the time spent using the applications and participants' achievement in reading comprehension.

**Table 6**

*Pearson Correlation between Posttest of Reading Comprehension and Time Spent Using Applications*

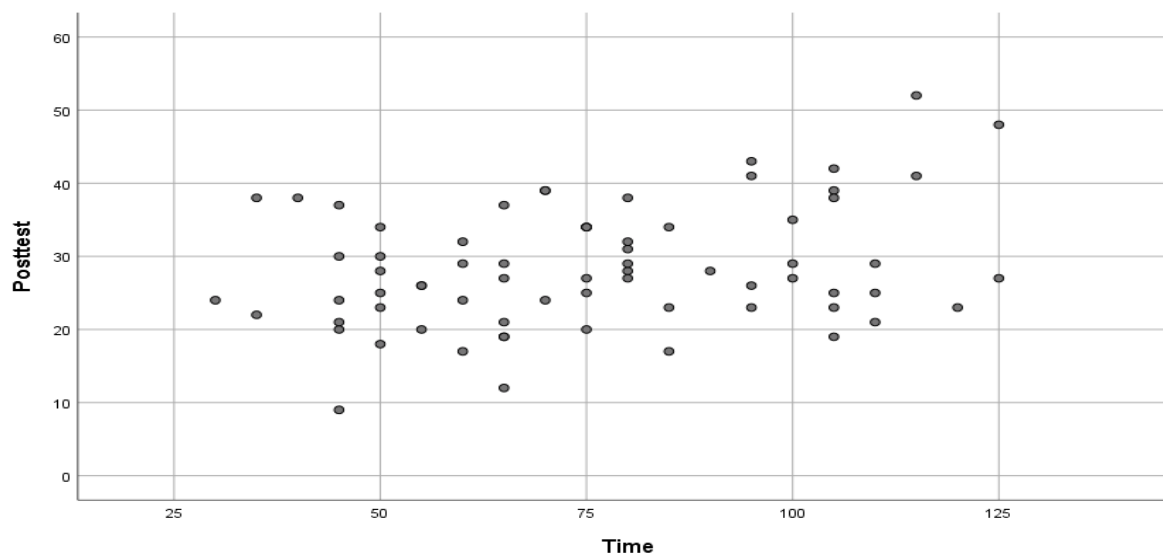
		Time
Posttest	Pearson Correlation	0.308**
	Sig. (2-tailed)	0.010
	N	70

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

Besides normality of data which was discussed in Table 6, Pearson correlation has two more assumptions; linearity and homoscedasticity which can only be probed through a scatter plot. The overall pattern of dots did not show a curve shape, although some rising-and-falling sections can be identified throughout the plot. However, the assumption of homoscedasticity was retained. Based on Figure 1 the spread of dots did not pile on one side of the graph; leaving a narrow tail at the other end.

**Figure 1**

*Difference between Female and Male Iranian EFL Engineering Students' Reading Comprehension Achievement Using Mobile Applications*



## 6. Discussion

Incorporating mobile technologies and gadgets into English language teaching and learning has been a focus for researchers, policy makers, and curriculum designers in recent years. Mobile application designers have produced educational applications aimed at providing education outside of the classroom, and one specific skill that has garnered attention from researchers is reading comprehension, particularly among engineering students. It is a critical skill that plays a significant role in their future careers and academic pursuits.

To answer the first research question, participants were asked if they were interested in using mobile applications to enhance their reading comprehension achievement. Jeong's (2017) research found that most participants claimed that learning English through mobile applications was more engaging than traditional methods. Moreover, mobile applications were more effective and motivating for the students, making them interested in studying English. Khrisat and Mahmoud (2013) and Muhammed (2014) reported similar findings on students' interest in using mobile phones and applications in EFL classrooms in the Saudi Arabian context.

Lee's (2014) study revealed that the majority of students prefer studying conventional printed course books, but learning English on gadgets improves their learning when used independently or combined with a teacher's instruction. However, Loan's (2009) study results were in contrast with Lee's, stating that modern technological devices have become a "Time Eating Machine," and the act of reading has become a closed book.

To address the second research question, Azadi and Azad (2017) reported that the experimental group significantly outperformed the control group on the post-test in both reading rate and comprehension while using mobile applications for reading. Hazaea and Alzubi's (2016) study found a direct relationship between the use of mobile WhatsApp, online and offline dictionaries and resources, and memos, and participants' reading comprehension achievements. Keezhatta and Omar (2019)

emphasized that MALL materials and systems enhance reading comprehension achievement among EFL students. In addition, Moon et al. (2017) found that student-centered reading comprehension activities on the iPad can lead to better student achievement in reading comprehension.

The study by Loewen et al. (2019) had similar results to the present study, indicating significant progress on L2 measures and a positive correlation between the amount of time spent on Duolingo application and learning gains. However, the findings of Ng et al.'s (2020) study were in contrast to the current study, showing that students spending more time on their smartphones learning the language did not display better performance compared to the ones spending less time.

Regarding gender differences in adoption and use of technology, Poushter's (2016) study found no clear understanding, while Cai et al.'s (2017) meta-analysis of 50 studies concluded that males still hold more favorable attitudes toward technology use than females. Yang's (2012) study found no significant differences between male and female participants' attitudes on MALL, while Viberg and Gronlund's (2013) study found that female students are more positive towards the use of mobile gadgets in language learning. Additionally, Tsai (2016) highlighted significant differences among various English proficiency levels' reading preferences between printed texts or electronic ones in male and female groups.

In summary, mobile technologies and gadgets have been integrated into English language teaching and learning environments. Reading comprehension is a critical skill that has gained attention from researchers, with studies showing that mobile applications are more engaging, effective, and motivating for students. MALL materials and systems have a positive impact on reading comprehension achievement, providing a motivating learning environment for students. However, further research is needed to understand gender differences in the adoption and use of technology.

## **7. Conclusion and Implications**

This study delves into the impact of mobile applications on enhancing the reading comprehension skills of Iranian EFL engineering students. The researcher utilized a placement test and two mobile apps to investigate the matter, involving 70 freshman and sophomore engineering students from Semnan University, Semnan, Iran. The findings revealed that the use of mobile apps has a positive influence on the participants' reading comprehension achievement, and they expressed great interest in utilizing such tools for educational purposes. The study also discovered a significant correlation between the time spent using mobile apps and reading comprehension achievement.

The outcomes of this research are of great value to curriculum designers and policymakers in the higher education sector, who can use the information to develop appropriate content for English language course books and allocate adequate class time to facilitate the instructional use of technology. University professors and teachers can also benefit from this study by encouraging students to engage more in the learning process inside and outside the classroom with the aid of technology, particularly mobile applications. The use of technology-based learning fosters communication between teachers and students, and even between students, helping them solve educational problems collaboratively.

Moreover, students can utilize various English language educational applications to enhance their language skills, including listening, speaking, reading, and writing, as well as sub-skills such as vocabulary, grammar, and pronunciation, at any time and from anywhere. It is claimed that there is a link between different language skills, and improvement in one skill can lead to enhanced performance

in others, unintentionally. Lastly, using innovative technologies in the EFL setting facilitates access to original resources and professional knowledge, particularly among engineering majors, for both teachers and students.

As with any study, it's important to acknowledge the limitations of our research. Firstly, we lacked a control group and all participants were categorized into one experimental group. Secondly, there was a lack of teaching sessions, with participants working independently without guidance. They only had the opportunity to ask questions during consulting sessions. The third limitation relates to our sample population, consisting solely of undergraduate students in two engineering majors: chemical engineering and materials science and metallurgy engineering. Lastly, our study focused on mobile reading comprehension applications designed solely for the Android platform. Participants who owned different mobile platforms were required to install the applications on their tablets or laptops using Android simulation software. While we recognize these limitations, we have taken steps to ensure the validity of our findings and hope that our research provides useful insights into the use of mobile applications for reading comprehension.

This study was limited to freshman and sophomore students with the objective of enhancing their reading comprehension skills, which will be beneficial for their future language proficiency, career prospects, and knowledge enrichment. In order to obtain more reliable results, it will be helpful to conduct broader studies across different majors with a larger number of participants using various educational applications. Our tone is professional and objective. The description is concise and informative, containing 115 words.

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### **Authors' Contributions**

All authors have conducted the study, collected data, analyzed and interpreted the data, and written up the manuscript.

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### **Competing Interests**

The authors declare that there is no conflict of interest.

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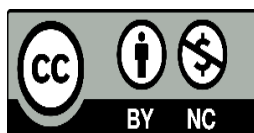
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