Enhancing Self-Regulated Learning Strategy via Handheld Devices for Improving English Writing Skills and Motivation

Mohamed A. Elkot and Rabea Ali

***Abstract*—This study investigated the impact of developing learning app via handheld devices based on some self-regulated learning strategies for improving English writing skills and motivation among intensive English language preparatory program students. The sample was chosen from English language preparation program students at college of sciences and Arts. The random sample consisted of (n=40) students. Those students were divided into two similar groups, Experimental and Control groups. To collect the data of the study, the Authors used a pre-posttest, interviews with the students and a motivation scale. T-test was used to compare between the two groups at the pre and post-test. The results revealed an observed improvement in writing skills, motivation, and attitudes for the benefit of experimental group. Moreover, the findings revealed that there were statistical differences between pre and post-test for the experimental group. No differences were found, according to the control group.**

***Index Terms*—Self-regulated learning, handheld devices, writing skills, motivation.**

I. Introduction

Information and communication technology (ICT) has an important role in our life after the large spread of using technology in recent years. Many researchers in education adopts using technology tools in their studies when they observed the effect of using technology in our life. In the educational field, the use of mobile technologies has a high significant role as they can offer many learning opportunities [1]. That effect has become clear in learning strategies as it is now embedded into different curricula.

Floyd [2] mentioned the importance of writing skill as it is an important aspect of language learning and they defined writing skill as the process of encoding the words. The authors tried to find a solution to this problem. They put in their consideration that the solution should be friendly, effective, available and attractive for the students. They think that the solution may be self-regulated learning based on mobile learning applications.

Accordingly, [3] claim that creating lengthy texts requires that writers should have some self-regulated learning strategies like cognitive, metacognitive, motivational processes. One of the most effective evidence-based methods for developing writing skills is the Self-Regulated Learning Strategy. According to, the theory of self-regulated learning (SRL), there are four main factors: metacognition, motivation, cognition, and behavior [4].

In [5] mentioned that learners who are perfect and have high knowledge and use of different self-regulated learning strategies like metacognitive and motivational have been shown to get higher literacy skills. Learners of using self-regulation strategies are capable of good planning, choosing suitable cognitive and metacognitive strategies, and evaluating learning outcomes.

Moreover, [6] sustained that self-regulation is a wide concept, including beyond metacognition and involves different factors like emotion, thinking, behavior and environment. These factors can help students in managing their thoughts, behaviors, and emotions in order to successfully navigate their learning experiences. Self-regulated learners are distinguished from their peers as they are more engaged commonly seating themselves toward the front of the classroom [7].

There are many studies related to self-regulate learning strategies with their applications. These studies proved their effects on the learning process. Using learning applications via handheld devices is called mobile learning (M-learning). [8] defined M-learning as using mobile applications in the educational system. These technological tools can present learning environments easily, anytime and anywhere. Thus, the researchers of the current study believe that using M-learning Apps are the best solution for solving this problem, especially after the widespread of using mobile phones among students in recent years. This opinion was established in the researchers' minds after the differentiation of the mobile-devices have had a clear attention in the field of teaching and learning. Also, [9] mentioned that mobile technologies have been widely involved in teaching and learning in different subjects in the educational process. Clearly, there are many studies done based on the applications of handheld devices in L2 learning and teaching that proves the effectiveness of these applications in language learning places. Moreover, many researchers carried out different studies based on applications of handheld devices in learning and teaching foreign and second language. They proved the effectiveness of these applications in language learning places [10]. Moreover, there are different studies based on mobile learning with different language skills like listening, speaking, reading, grammar and vocabulary [11], [12].

II. Problem Statement

The study problem can be summarized in the following:

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There is a clear weakness in English writing skills among intensive English language preparation program students. The researchers observed that weakness through teaching English writing course. Also, English writing skills weaknesses are clear via home assignments, midterm, and final exams. The students are weak in different writing skills like grammar, organization, unity, and coherence.

The current study tried to answer the following research questions:

1) What is the effect of enhancing self-regulated learning strategy via handheld devices on improving English writing skills?
2) What is the effect of enhancing self-regulated learning strategy via handheld devices on students' motivation for learning?
3) What are the students' attitudes towards using the learning application via handheld devices based on self-regulated learning strategy?

III. Review of the Related Literature

A. Self-Regulated Learning (SRL)

One of the most important goals of education development is to enhance students` ability in learning how to learn. To achieve this goal, teachers should teach the required knowledge, skills and strategies for their students. Learners should be skillful in these strategies. Self-regulated learning theory was introduced in the 1980s by Zimmerman and it has continued to be effective for researchers and teachers. The importance of Self-regulated learning (SRL) is the nature of learning environments requires perfect self-regulation skills [13].

In [14] mentioned that there are four categories of SRL: (a) metacognition (planning, setting goals, monitoring, and evaluating); (b) motivation (one's capability to self-motivate, shouldering responsibility for successes and failures and enhancing self-efficacy); (c) cognition (strategies to understand and remember information), and (d) behavior (help-seeking and creating a positive learning environment for learning task).

According to, [3], [15] self-regulated learning theory helps students to follow up on their learning strategies without depending on teachers and classmates except if there is a necessity. Also, [6] mentioned that during the university stage, students should be independent learners as the academic success of this stage is affected by the students' ability to learn independently. Additionally, learners who have Self- regulated strategies; they also show good performances and higher abilities to regulate the learning process so they can achieve their goals [16], [17].

In addition, many studies have shown that learners who are good users in self-regulated learning strategies; they can achieve a clear academic success [13]. Moreover, the difficulty of learning content and the complexity of the learning environment in the learning process need learners capable of regulating their own learning. Thus, it is very important to help learners to be proficient in their own learning.

B. Handheld Devices for Learning

In the learning process, the concept of handheld devices is called M- learning, as it was shown via handheld devices in social media and community participation. M-learning is considered one of the electronic learning types based on information and communication technology. Moreover, Huang, [18] defined M. learning as a communication channel between the instructor and learners to support the educational content and continuous response among them.

According to the availability of the characteristics and merits of the handheld devices, the current research adopted this technique, especially after its widespread, to develop the learning application that supports some of these devices (Smartphones-I pod –Tablets). [19] Proved that there is a relationship between using technology and self-regulated learning strategies as the handheld devices have a clear role in comparison with the rest of technology types. There are convergent chances among learners to arrive in learning applications after the large spread of handheld devices. This creates an active learning environment that learners can perform and use it quickly and easily. All these merits and characteristics of handheld devices are the reasons that the researchers think of using that technology with intensive English language preparation program students. Many of those students live hundreds of kilos fare from the main campus and their regions do not have Infrastructure for electronic learning.

Because of increasing using handheld devices in reading, writing, discussing, and chatting, instructors can use that attractive environment for teaching English as a foreign language. As a logical result of what it is above-mentioned of the importance of self-regulated learning strategies, learners will be more active and interactive when they are self-directed. In addition, after the international orientations to redesign, organize, and rebuild the curricula, the researchers designed the current application that it was based on supporting some self-regulated learning strategies.

The authors used three strategies. They are metacognition (commitment to the learning goal, planning, and follow-up), motivation (adjustment of mood, making learning attractive), and cognition (regulation, use of cognitive strategies) for developing EFL writing skills. In the application, the main screen was divided into some parts as it is shown in the Fig. 1. The parts of the application supported the targeted self-regulated learning strategies.

Accordingly, there are many studies dealt with using handheld devices or mobile-assisted language learning (MALL) in English language learning [20]-[22]. Their results were clear progress with different English language skills like reading, listening, and speaking. Also, [10] mentioned that there is a great effectiveness of mobile applications for English language vocabulary and grammar [23]. In his study, [24] proved that using the iPod touch with English language learners improved the learning process along with distinct challenges. Although the teachers faced some challenges when his students used the iPod touch in the learning process, the mobile learning device (iPod touch) showed its importance in the learning process.

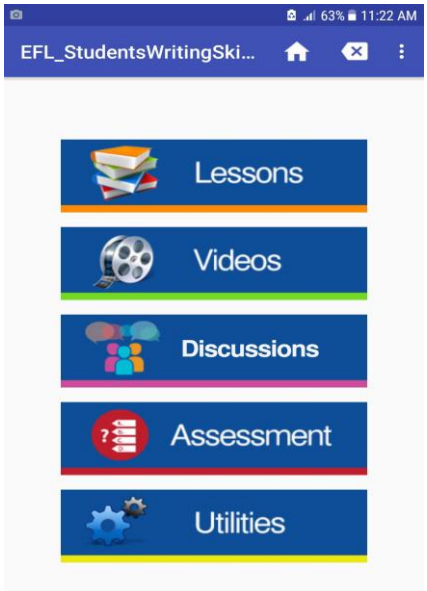

Fig. 1. Shows the main screen of the App.

Besides, [25] mentioned that the aim of their study was to investigate the impact of the design and application of self-regulated learning, through the application of smart devices to provide the students with training and evaluation in the mathematics and science courses in order to develop the students' academic skills and train them to use technology in the learning process. Moreover, mobile devices can be good supporters in learning as they are available in daily life and easy use. Thus, the learning process occurs in a natural way and the learners can learn easily in an enjoyable environment [3]. Additionally, [26] proved in their study that the participants showed positive attitudes towards the instruction and the learning system, and their listening comprehension improved significantly in this case study. Furthermore, [24] aimed in their study to investigate the different ways of acquiring knowledge (vision and tactility) and self-regulated learning levels by using a tablet-based application, as well as investigating the interaction between these methods and self-regulated learning skills. (99) Students were selected and divided into three groups according to their high and low self-regulated learning skills. The results showed that the media-based group of tablet methods was better in acquiring knowledge than the other groups.

C. Self-Regulated Learning and Handheld Devices

There is a clear relationship between self-regulated learning and the characteristics of students who perform well in the digital world. Some studies (e.g., [27]-[29] have fulfilled English language learners' self-regulated learning in technology-enhanced learning environments, and have found interesting models for analyzing their online self-regulation. Mobile devices and learning applications have important effects on the mobile collaborative learning activities. According to [30] mobile-bate students' learning with instructors, classmates, and society, both in and outside of the class room collaborative learning is an important new learning trend to advocate, encourage, and facility. To identify more about this issue, [17] reviewed some studies and found that the number of studies on mobile collaborative learning increased and the connection between new mobile technology and collaborative learning activities became tighter. Recent studies reported that using SRL skills based on online learning environment confirmed positive results for learners [31].

Furthermore, there are many researchers dealt with web-based self- regulated learning system to facilitate self-regulated learning. Additionally, [32] developed a multiple-choice web-based assessment system to help learners to perform self-regulated learning by the peer-driven assessment module and test analysis system. The results were positive as the system had a good effect in facilitating learners to perform self-regulated learning and in improving their e-learning effectiveness. Besides, [33] developed a digital reading annotation system with self-regulated learning mechanisms to facilitate English-language reading performance. They proved that the system has a clear significance in the reading comprehension and reading annotation abilities through their system. Self-regulated learning is seen to be an important part of success in online learning environments [29]. In spite of the fact that self-regulated learning strategies were mainly developed in web-based learning environment, few strategies were used via handheld devices. Actually, learners can learn via handheld devices anywhere and anytime. Therefore, it is better to develop a mobile self-regulated learning system to enhance students' self-regulated learning abilities.

IV. Methodology

A. Participants

The research participants for the current study were forty students. They were male students at Qassim University, Saudi Arabia who were studying in an intensive English language preparatory program. The 40 students were randomly matched into two groups. One of them studied via the learning application of the current study and the other group studied through the blended learning. Every group included 20 students. The participants of the experimental group downloaded the application via their devices and studied the content of the writing course. The other group studied the same course via the blended learning. To collect the data of the research, qualitative data (questionnaire) and quantitative data (pretest and posttest) were used.

B. Instruments

1) The learning application

This app was based on Java language. The researchers divided it into five sections as shown in (Fig. 2).

The lessons section: it was about the lessons that the students in the experimental group studied. The content of these lessons was about the basic writing skills (unity, coherence and organization). Additionally, the researcher explained the meaning of every writing skill for the students and how they apply these skills in their writing via the self-regulated learning strategies. The video section: In this section, the researchers uploaded some videos related to the English writing skills. These videos have helped the students to identify how they apply these skills, while they were writing English paragraphs. The discussions section: this section was an interactive learning environment.

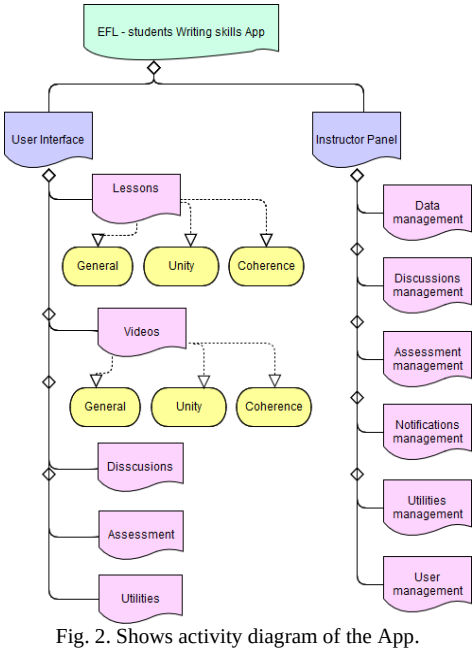

Fig. 2. Shows activity diagram of the App.

The students could make discussions among themselves and with the researchers. According to the students' opinions, this section was very useful, interactive, and interesting. The assessment section as shown in (Fig. 3): it included some evaluated exercises. These exercises were varied. In this area of the learning app, the students' answers were self-evaluated and the students received the feedback about their answers. The strategy of using this section helped the students to use their self-regulated learning strategies while they were writing or answering some writing exercises. The utilities section: in this section, there were many useful tools for the students that could help them in learning English grammar. Online correction was one of these tools. It was designed to find spelling, as well as basic grammar and stylistic mistakes, in English text.

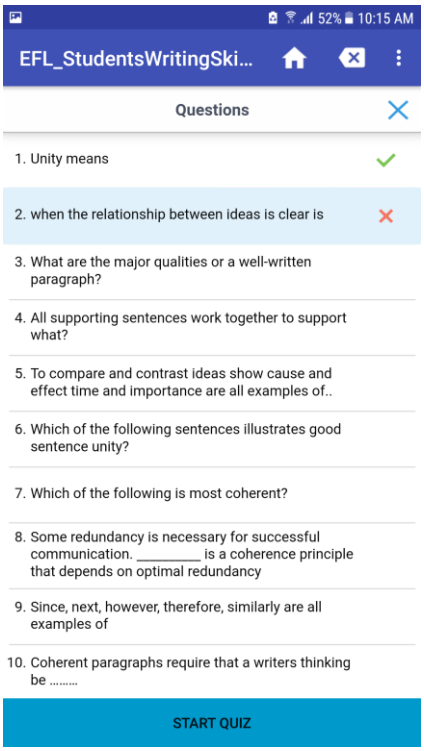

Fig. 3. Shows samples of the assessment.

2) English writing test

Before carrying out the test, the researchers did a pilot study to determine the current situation of the writing skills. The researchers designed an English writing test, which was examined by some English instructors who are specialists in teaching English as a foreign language. This test was developed for measuring students 'English writing skills. The test included two parts. The first part was related to grammar (punctuation & rewriting some sentences in a correct order). The second part was related to writing a paragraph to measure some writing skills (unity, coherence, and organization).

3) Motivation scale

A scale of motivation towards using learning application via handheld devices based on some self-regulated learning strategies was applied to the students to measure their motivation towards the application. The scale was consisted of (20) items. It was applied as a pre-post scale for both groups. This scale was designed by the researchers of the current study.

4) Interviews

To collect the related data of the current study, the researchers prepared semi-structured interview. Questions of the interview were examined by the second researcher (a curriculum and instruction expert) and applied to some students. They were randomly selected from the experimental group to get their opinions. The students' statements were quoted and transcribed identically. As a result of the interviews, the researchers coded statements and compared their codes in order to ensure the reliability of the data obtained.

5) Design and procedures

The research experiment:

This research was carried out in the second term (from the twenty-five of February to the twenty-five of April) of the 2019 academic year. Data were gathered via a pre-posttest, motivation scale (quantitative phase). Moreover, some interviews and observation cards (qualitative phase) were conducted to identify what extend the application of the current study was the main reason to motivate the participants towards learning.

To validate the pre-posttest and motivation scale, three experts of English language teaching (the second author of this study was one of them) evaluated the appropriateness of the items. The motivation scale asked the participants for indicating what extent they agreed or disagreed, by using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), that the learning application based on self-regulated learning motivated them towards learning English writing skills. In addition, the researchers distributed the pre-test for the participants before applying the experiment. The research experiment continued eight weeks as the following:

Week one: The researcher presented an introduction about the self-regulated learning strategies and their relation to English writing skills. Also, he showed the importance of acquiring these skills to be perfect in writing paragraphs and essays. Accordingly, the students mentioned that the traditional teaching methods were the main causes that they made them weak in performing English writing skills. They hoped if there was any electronic learning app to help them to

be perfect in writing skills. The researcher clarified the advantages of mobile learning apps comparing with other learning methods. He explained the way of downloading the app and he gave a background about every icon in the app.

Week two (English writing skill "Grammar"): The researcher started to teach the lessons. He asked the students for discussing any exercises with their instructor or classmates via the app. All of the group can exchange the thoughts and the experiences. As well as, the content of the lessons was based on self-regulated learning. During this week, the researcher could finish the activities of the lessons that they were related to English writing skill (grammar). Finally, the students watched the related videos and answered the exercises.

Week three (English writing skill "unity"): As a warming up activity, the researcher asked the students for identifying the meaning of the unity skill in writing. All of the students watched the related videos that could help them identify this meaning. Moreover, they studied the related lessons and exercises. The students used the assessment section to answer some related exercises to be sure they understand the target skill.

Week four (English writing skill "coherence") In this week, the researcher taught the coherence skill. The students were asked for watching the related videos to identify the meaning of this skill. In the discussion section, the students added more definitions for this meaning as a way of thoughts exchange among them. Moreover, they practiced some exercises that helped them to make the coherence in their writing.

Week five (English writing skill "organization") In this week, the researcher asked the students for watching the related videos. They studied the content of the lessons. They made some discussions about the organization skill and how they apply it in their paragraphs. Furthermore, they answered some related exercises in the assessment section.

Week six and seven (writing paragraphs): In these weeks, the students practice English writing skills (unity, coherence, organization, and grammar) through writing some paragraphs. The researcher sent some different topics via the app. He asked the students for typing and sending these paragraphs through the assessment section. Every student received the feedback about his writing.

Week eight (Revision and evaluation the educational app): The researcher asked the students some questions (the interview) about the app. The students' comments were very useful for the researchers as they could treat some issues. Some of the comments were that the students needed more videos and exercises.

V. Results and Discussion

In the light of the collected data after the completion of the basic research procedures, the statistical analysis program (SPSS) was used. The following steps are the statistical analysis.

To answer the first research question: (What is the effect of enhancing self-regulated learning strategy via handheld devices on improving English writing skills?), Paired-Sample T test was used to measure the difference between the mean scores of the pre-test and the mean scores of the post-test of these experimental group for improving writing skill.

It is clear from Table I that there was a statistical significant difference between the mean scores of the pre-test (mean = 9.70) and the mean scores of the post-test (mean = 13.70), T = 7.059 at a mean level (p = .000) less than the value of α = 0.05 in favor of the post-test. The participants' writing skills increased as it was clear from the marks of the post-test, this ensures that using the mobile educational application based on some self-organizing learning strategies had a positive effect. This result is consistent with [34]-[36].

TABLE I: Shows the Differences between Pre-Test and Post-Test in the Experimental Group Using Paired-Sample T Tests

G	Mean	N	Std.D	Std. Err	t	P (2-ailed)
Pre	9.70	20	4.092	.915	7.059	.000
Post	13.70	20	3.840	.859		

The researchers pointed out that using self-regulated learning strategies based on mobile learning environment through mobile devices is a variant of the traditional learning pattern and it was a major cause of the previous mentioned results. It means that the current app has an impact in acquiring the students with writing skills.

Paired-Sample T test was used to measure the difference between the mean scores of the pre-test and the mean scores of the post-test of the control group for improving writing skill, as shown in Table II.

TABLE II: Shows the Differences between Pre-Test and Post-Test with the Control Group Students Using Paired-Sample T Test

G	Mean	N	Std.D	Std. Err	t	P (2-ailed)
Pre	9.18	20	3.690	.825	2.763	.012
Post	9.80	20	3.806	.851		

It is clear from the previous table that there was a statistical significant difference between the mean scores of the pre-test (mean = 9.18) and the mean scores of the post-test (mean = 9.80), T = 2.763 at a level of significance (p = .012) less than the value of α = 0.05 for the post-test. This was an indicator that writing skills were increased with the control group students who study the writing skills with the traditional way. It was noted that the difference between the mean of the pre-test and the mean of the post-test is small, indicating that the improvement rate was slight compared to the observed improvement rate between the pre-test and the post-test in the experimental group. The researchers pointed out English language skills, especially writing skills in the traditional form of learning, face many difficulties and obstacles in building a real interactive environment between the student and the teacher with direct and immediate feedback. This result is consistent with [36], [37]. An independent-sample T test was used to measure the difference between the mean scores of the post-test for the experimental group and the post-test scores of the control group for improving writing skill, as well as to verify the homogeneity between the two groups as shown in Table III.

TABLE III: Shows the Differences between the Mean Scores of the Post-Test for the Experimental Group and the Mean Scores of the Post-Test for the Control Group Using

G	M	Std.D	Std. Err	t	F	Sig	df
Exp.	13.95	3.379	.756	2.763	.184	.670	38
Control	9.30	3.511	.785				

It is clear from the results of the previous table that the value of (F) = .184 and its significance level is .670. This value is greater than 0.05, which indicates that it is not significant (this means that there is a homogeneity between the two groups) t-test = 4.268, degrees of freedom df = 38, and the value of Sig. (2-tailed) = 0.000, as the value of Sig. (2-tailed) in the table is smaller than the α = 0.05 value, it indicates that there is a statistical significance differences between the mean scores of the experimental group and the control group in favor of the experimental group. This indicated that the development and improvement of writing skills were increased in the experimental group compared to the control group. The researchers interpreted this result for the following reasons:

The application gave the experimental group the opportunity to communicate and interact continuously with the researchers and their peers at any time and from any place.

Although the two groups (experimental and control) study the writing skills by electronic way, the results of the experimental group were higher than the results of the control group. This shows the positive effect of the application.

To answer the second research **question:** (What is the effect of enhancing self-regulated learning strategy via handheld devices on students' motivation for learning?), Paired-Sample T test was used to measure the difference between the mean scores of the pre-test and the post-test scores for the experimental group of students' motivation towards learning.

TABLE IV: SHOWS THE DIFFERENCES BETWEEN PRE-MEASUREMENT AND POST-MEASUREMENT IN THE EXPERIMENTAL GROUP USING PAIRED-SAMPLE T TEST

G	Mean	N	Std.D	Std. Err	t	P (2-ailed)
Pre	13.60	20	4.018	.899	13.381	.000
Post	21.90	20	4.553	1.018		

It is clear from Table IV that there was a statistical significance difference between the mean of the pre-test scores (mean = 13.60) and the post-test scores (mean = 21.90), T = 13.381 at a mean level of (p = .000) less than the value of α = 0.05 for the post-test. it indicated that the motivation of the students' experimental group increased after they used the mobile educational application based on some self-regulated learning strategies, and this result is consistent with the results of the studies [12], [18], [21]. Clearly, the researchers think the cause of this result is using the mobile learning application of the current study. Paired-Sample T test was used to measure the difference between the mean scores of the pre-test and the post-test of the experimental group of students' motivation towards learning.

TABLE V: SHOWS THE DIFFERENCES BETWEEN THE PRE-MEASUREMENT AND POST-MEASUREMENT OF CONTROL GROUP STUDENTS USING PAIRED-SAMPLE T TEST

G	Mean	N	Std.D	Std. Err	t	P (2-ailed)
Pre	13.95	20	3.818	.854	4.357	.000
Post	16.30	20	4.169	.932		

It is clear from Table V that there was a statistical significance difference between the mean scores of the pre-test (mean = 13.95) and the post-test (mean = 16.30), T = 4.357 at the mean level (p = .000) is lower than the value of α = 0.05 for the post-application. This indicated that the students' motivation towards learning increased among the control group students who studied the unit by the traditional way. It was noted that there was a simple difference of the mean scores between the pre-test and the post-test of the control group comparing to the experimental group as the differences was big. It indicated that the improvement rate was slight compared to the improvement of the experimental group. The researchers reported that the students 'motivation towards learning has been influenced by self-regulated learning strategies based on the electronic application. This result is consistent with the results of the studies of [20], [38], [39].

An independent-sample T test was used to measure the significance of the difference between the mean scores of the post-test for the experimental group and the mean scores of the post-test for the control group of students' motivation towards learning, as in Table VI.

TABLE VI: SHOWS THE DIFFERENCES BETWEEN THE MEAN SCORES OF THE POST-TEST FOR THE EXPERIMENTAL GROUP AND THE MEAN SCORES OF THE POST-TEST FOR THE CONTROL GROUP

G	M	Std.D	Std. Err	t	F	Sig	df
Exp.	21.90	4.553	1.018	4.057	.236	.630	38
Control	16.30	4.169	.932				37.709

It is clear from the results of Table VI that the value of (F) = .236 and its significance level is 630. This value is greater than 0.05, which indicates that it is not significant (that is, there is homogeneity between the two groups). This leads us to read the results of t t-test = 4.057, degrees of freedom df = 38, and the value of Sig. (2-tailed) = .000, since the value of Sig. (2-tailed) in the table is smaller than the α = 0.05 value. It indicated a statistical significance difference between the mean of the experimental group and the control group in favor of the experimental group. This indicated that the motivation of students towards learning has been increased in the experimental group compared to the control group. The researchers think that the cause of this this result is using the learning application based on self-regulated learning strategies via handheld devices.

To answer the third research question: (What are the students' attitudes towards using the learning application via handheld devices based on self-regulated learning strategy?), all the participants were invited to take part in the interviews. Regarding to the qualitative phase in this research, some interviews were also undertaken. The questions of the interviews were:

- What do you think about using self-regulated learning strategies in learning English writing skills?
- What do you think of the benefits of using handheld devices in English writing skills?
- What are the challenges that you faced during applying the learning application?
- What are your suggestions for improving this application?

After the researcher finished the interviews with the students, some issues were clear via the answer of the third question in the interview. The learners asked the researcher for uploading more exercises and videos about writing skills.

VI. CONCLUSION

In conclusion, the aim of this study was to identify the

effect of using the learning application based on self-regulated learning via handheld devices in learning English writing skills and developing the motivation and attitudes among the intensive English language preparation program students. Some instruments were used to prove the effectiveness of the current app. English writing test, motivation scale, interviews, observation cards and the educational app were the instruments of the current study. Quantitative results revealed that the participants' English writing skills and motivation were improved through the learning app. Accordingly; these results echo the studies of [19], [31], [40]. Moreover, the interviewees had positive attitudes towards the app. They mentioned that it was very interesting and useful. It helped them to have the enthusiasm to study more instead of using the boring traditional method. Additionally, the participants mentioned that the learning app created an interactive learning environment as they could exchange many discussions with their peers and the instructor. According to the students' opinions, the educational app was easy use anytime and anywhere. Consequently, these results were consistent with the studies of [41]-[46].

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Mohammed. A Elkot conducted the research, developed and designed the Mobile App, implemented the proposal, and analyzed the data.

Rabea Ali supervised the whole activities including the experiments and wrote the paper. All authors came up with the idea and proposal for the research and had approved the final version.

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