Integrating Mobile Games in Arabic Orthography Classrooms

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Abstract
Considerable advances in the capabilities of modern mobile devices have enabled their use as powerful educational tools. Today, mobile learning games are widely used as creative platforms for teaching and learning, offering enjoyable and ubiquitous educational content. This study describes the design and evaluation of a mobile Arabic orthography game aimed at improving Arabic orthographical skills among young learners. In particular, 52 female fourth-grade students participated in this study to answer the following research questions: what impact does the use of mobile Arabic orthography games have on students' performance, and how do students perceive this learning approach? A mixed-method research design was adopted to answer these research questions, including pre-and post-tests, interviews, and classroom observations. Analysis of the data revealed that, although there were a few challenges involved in using mobile games as a learning tool, significant improvements were found in students' performance and engagement, and positive attitudes were developed towards using the mobile game. In addition, there was an overall increase in students' motivation and interaction. The pedagogical implications of these findings can be linked to the gamification of the teaching and learning environments. Teachers are encouraged to consider integrating mobile educational games into their instructional approaches, as they can serve as great incentives to learning (especially for young students).

Keywords: Arabic orthography, language teaching and learning, mobile-assisted language learning, mobile games

Introduction

Mobile games have become essential tools for young learners in the 21st century (Prensky, 2001). These digital-native learners have become accustomed to using touchscreen devices from an early age. This has allowed them to develop a unique set of abilities, such as the abilities to exercise control and to manage planning and problem-solving tasks (Grose, 2013; Sharkins, Newton, Albaiz, & Ernest, 2015; Papadakis,& Kalogiannakis2017). According to Cohen, Hadley, and Frank (2011), children younger than two years can use mobile devices; they can interact naturally with a touchscreen as they would instinctively play with a new toy (Sharkins et al., 2015). Similarly, Grose (2013) found that two- to five-year-olds can manipulate apps more capably than they can tie their shoelaces or ride bikes. However, many researchers believe that this scenario has created a worrying gap between the expectations of young learners and what they find in traditional classrooms (Furió, Juan Vivó, 2014). It has also been argued that game-based learning constitutes a more practical approach to teaching and motivating young learners (Furió et al., 2014, Prensky, 2001; Chang et al., 2007). According to Chang et al. (2007), game-based learning refers to any educational method that embeds instructional materials or learning designs within the activities of a digital game to engage learners in simple tasks or complex problem-solving activities. However, mobile learning games have not been sufficiently explored, and there is a strong need for more empirical studies on the impacts of these games on teaching and learning (Chen, Cheng, & Hao, 2019; Booton, Hodgkiss & Murphy, 2021). Hence, in this study, we describe the design and evaluation of a mobile Arabic orthography game for improving Arabic orthographic skills among young learners. Our study poses the following research questions:

      • RQ1: What impact does the mobile Arabic orthography game have on   the performance of elementary school students?

      • RQ2: How do Arabic elementary school students perceive this learning approach?

The remainder of this paper is organized as follows. The following section explores the literature on the use of mobile games in language learning, followed by a description of the study's design and procedures. Then, the results of this study are reported and discussed. Finally, we present the research implications and conclusions, along with suggestions for future work

Literature Review

Mobile Learning Games

Mobile learning games have been shown to have significant impacts on language learning. Mobile learning games have gained considerable popularity among young learners in recent years, and many researchers believe that such games can enhance the teaching-learning environment (Yamato, Corrêa, & Martins2017; Chaves et al., 2018; Bhide et al., 2019; Vanbecelaere et al., 2019; Juhani Lyytinen, Semrud-Clikeman, Pugh & Richardson, 2021; Alotaibi, & Alharbi,2022; Amorim et al., 2022). According to Johnson et al., (2013), mobile learning games significantly promote engagement, creativity, and authentic learning. Other studies, e.g., Lameras et al. (2016) and Bartram, Bradley and Al-Sabbagh, (2018) have indicated that mobile technology encourages informal and incidental learning, and that these can occur without being intended or planned. According to Bartram et al. (2018), "this is what happens in everyday life in activities that are not traditionally designed as learning events, such as engagement in leisure pursuits or social interaction, which nevertheless create opportunities for language acquisition."

For example, Acquah, and Katz, (2019) conducted a systematic literature review of research on the effectiveness of digital games as learning tools. They considered studies conducted between 2014 and 2018 focusing on students aged 6–18 years. The researchers in the surveyed studies found that digital games can effectively promote language acquisition, contemporary competencies, and participatory behavior. Their findings also revealed six features of digital games that positively impact outcomes: ease of use, challenges, rewards and feedback, control or autonomy, goal orientation, and interactivity. The researchers concluded that digital games could be effective teaching and learning tools. However, they encouraged further research to explore the successful implementation of digital games in classrooms. Zaibon and Shiratuddin (2010) argued that the following learning theories must be used to support active mobile learning games: behaviorism, which focuses on providing the learner with reinforcement and control by providing effective feedback; cognitivism, which facilitates and supports the transference, remembrance, and recollection of knowledge; and constructivism, which provides learners with opportunities to explore and acquire knowledge according to their needs.

Mobile Games and Young Learners' Orthography Skills

Several studies (Yamato et al., 2017; Chaves et al., 2018; & Wijaya, 2018; Juhani et al., 2021; Amorim et al., 2022) have examined the impacts of mobile game use on young learners' orthography skills, and have reported significant performance improvements among learners and positive attitudes towards the use of these games. Yamato et al. (2017) designed a mobile game named "AmarganA" to enhance players' knowledge of Portuguese orthography. The learners' task was to shuffle letters until they found the correct spelling. Ten elementary school students evaluated the game, and the results indicated that the game could promote Portuguese language learning and stimulate creativity. Similarly, Chaves et al. (2018) explored an educational game developed to aid in the learning and teaching of the accent and hyphen rules of a new Portuguese orthographic agreement. The game-based approach effectively enhanced student engagement and motivation. In another study, Adi et al. (2018) incorporated a spelling game into English vocabulary lessons for 50 kindergarten students divided into four small classes. Their data analysis revealed that the students positively perceived this teaching approach, and were motivated and engaged in class activities. However, no evidence has been provided regarding the impacts of mobile games on student performance. Bhide et al. (2019) created a mobile game to teach fourth-grade students Hindi decoding skills, emphasizing the complex Akshara orthography used in Indian languages. They noted improved recognition skills and abilities in reading and spelling words containing the complex Akshara orthography for the students. Furthermore, the students successfully provided correct answers when the game progressed more quickly.

For young Arabic learners, further exploration of this topic is required, because there are a limited number of studies on game-based learning. Alsswey, Al-Samarraie, El-Qirem, and Zaqout, (2020) collected and analyzed 31 research papers published between 2010 and 2018 to explore research on students and instructors' use of mobile learning in the Arab Gulf countries. They found that these studies primarily considered mobile learning service accessibility, and argued that "a wider view about the influence of engaging students in mobile learning activities on their learning performance is needed" (Alsswey et al., 2020).

Indeed, only a few studies have examined the use of mobile learning games to improve students'

Arabic skills (Erradi, Nahia, Almerekhi, & Al-kailani, 2012; Karkar, Al Ja'am, Foufou & Sleptchenko, 2016; Alobaydi, Alkhayat, Arshad & Ahmed, 2017; Al-Khalifa, Faisa & Al-Matham, 2018; Al-Razgan & Alotaibi, 2019). Erradi et al. (2012) described the design and development of a multimedia mobile learning platform named "ArabicTutor" to aid in the teaching and learning of Arabic spelling and vocabulary. This game provided users with a list of words and their definitions, sample sentences, and multimedia illustrations. The program also provided other related linguistic and morphological information, such as explanations of the parts of speech of sample sentences. However, the proposed system was not evaluated, and the effectiveness of ArabicTutor insofar as language skill improvement was not tested.

Karkar et al. (2016) developed an Arabic-based mobile educational system for automatically generating illustrations of Arabic stories through text processing while providing Arabic educational ontology, general knowledge, and relationship extraction using online search engines. The system was evaluated for 20 children between nine and 10 years of age, classified according to four different levels. The reading time in seconds and number of correct answers were determined for the evaluation. Users who spent more time reading and accessing images generated by the system tended to achieve higher scores. The researchers concluded that their system improved the students; learning capabilities, memorization skills, communication, and understanding. Alobaydi et al. (2017) designed a prototype for a context-aware ubiquitous mobile learning game called "U-Arabic." This study aimed to enhance Arabic vocabulary acquisition among Malaysian children. The researchers evaluated their prototype by conducting a two-week pre-and post-test experiment involving 20 students in an elementary school in Malaysia. They administered a questionnaire to explore participants' attitudes towards learning using a mobile game, and revealed improved learning among the students. Despite the limited number of participants and short duration of the evaluation process, the researchers argued that mobile games could successfully attract students' attention towards learning, and motivate them to focus on vocabulary learning.

In Saudi Arabia, where Arabic is the native language, Arabic reading and writing are taught from the first grade until the end of the sixth grade. During the first three years of elementary school, students arere taught how to write and pronounce Arabic letters. They write two-letter and three-letter words until they can eventually write complete sentences. Arabic orthography consists of 12 levels; these are taught to students both directly and indirectly by focusing on correct handwriting. When students reach third grade, they are expected to be able to read and write a simple paragraph. Arabic language teachers usually review previous orthographic rules to ensure mastery before introducing new rules. The traditional instructional approaches used to teach orthography involve explaining orthography rules and extracting samples from passages, followed by oral dictation. Among other methods, students are given a list of words and asked to form complete sentences. However, traditional instructional approaches are usually criticized as ineffective (Abu-Rabia & Taha, 2013; Brosh, 2015).

The number of mobile games designed explicitly for native Arabic speakers is limited. Faseeh is a popular mobile game targeting Arabic learners developed by Al-Khalifa et al. (2018). It assists Arabic speakers in acquiring word synonyms to enhance their linguistic and expressive abilities. Al-Khalifa et al. (2018) evaluated the game by assessing player satisfaction through an evaluation

survey of the user experience and game design. Although the survey revealed a positive overall evaluation, no empirical research has been conducted to investigate the effectiveness of the game in enhancing students' linguistic and expressive skills. Al-Razgan et al. (2019) reported developing and evaluating a personalized mobile language learning system named "Afaneen" for teaching and improving spelling. Their game involved a practical component in which learners could practice a specific spelling rule, along with a component in which learners played a spelling game and recorded their progress. The researchers tested the system in a class of six male third-grade students in a Saudi elementary school using two evaluation approaches: a holistic test case scenario, and an in-class testing session. Data gathered through observations and interviews indicated an overall positive attitude towards the system. However, the researchers acknowledged the small sample size, and suggested that the study validity could be enhanced by testing the game's impact on student performance in a larger group of learners.

In a study conducted during COVID-19, Al-Jarf (2021) examined the differential effects of mobile devices on L1 and L2 learning among Saudi children. The study included 78 parents and 118 children. The children were grouped into 1–6 years old (young children in kindergarten and preschool), 7–9 years (grades 1–3), and 10–12 years (grades 4–6). The survey results showed that the iPad was more effective in helping the young children with language learning than the older children in grades 1–3 and 4–6, respectively. The older children mainly used iPads to play games and watch movies. The researcher concluded that mobile devices can help children focus on and engage in learning because the apps are interactive and use color, animation, audio, and video. The researcher recommended integrating reading story apps into the reading curricula at schools to familiarize students with these apps and encourage them to read at home.

The literature review presented above highlights the strong need for additional empirical studies investigating the effectiveness of mobile learning games in improving Arab students' orthography skills, especially for young Arab learners. Therefore, this study aimed to describe the development and evaluation of a mobile Arabic orthography game designed to improve Arabic orthographic skills among young learners. Through this research, we examined at (1) the impact of the mobile Arabic orthography game on the performance of elementary school students and (2) how they perceived this learning approach.

The study results are expected to shed light on the pedagogical implications of mobile games and impacts of integrating these tools into instructional approaches, especially for young students. The following section describes the development of the mobile game used in this study and its design and procedures.

Methodology

This study aimed to investigate the impact of a mobile Arabic orthography game on student performance, and to examine the perceptions of this learning approach. A mixed-method research design was adopted to address these research aims, along with a one-group pre-test/post-test design. According to Allen (2017), this type of research design "is most often used by behavioral researchers to determine the effect of a treatment or intervention on a given sample." This research design has two main features: (1) there is a single group of participants, i.e., all participants are subjected to the same treatments and assessments, and (2) linear ordering is used in the assessment,

i.e.,, testing is performed before and after treatment. In this study, qualitative data collection methods such as classroom observations and participant interviews were also incorporated. The following subsection describes the Arabic orthography game used in this study and its procedures.

Arabic Orthography Game

The study used Alemla Almotqan ("Perfect Spelling"), a mobile game designed by Al-Razgan et al. (2019) with the assistance of expert Arab language instructors, to enhance Arabic orthographic skills through an error-discovery approach (see Figure 1).

Figure 1. Mobile game interface

The instructional content of the game (i.e., the text and orthography rules) was adapted from the Arabic books used in the Saudi elementary school curriculum, and was revised by three expert Arabic language instructors with more than 15 years of experience. To personalize the game towards individual student abilities, a genetic algorithm (GA) approach was adopted in designing the game. The GA was first introduced in 1962 (Back, T., Hammel, U., & Schwefel, H. P., 1997), and can be defined as a heuristic search method used in artificial intelligence and computing to find "optimized solutions to search for problems based on the theory of natural selection and evolutionary biology" (Bheemaiah, 2017). The GA searches for the best query result among large and complex datasets, targeting and presenting the best solution unknown beforehand (Prensky, 2001; Crompton, H., Burke, D., & Gregory, K. H., 2017). The app was designed as a single-player, real-time mobile game. The game algorithm checks the input and outputs the corresponding pop-up menu for the correct input (Al-Razgan et al., 2019). The game allows for certain actions, as follows. First, game initialization occurs (no log-in is required). Then, the user can select between "play" and "practice" options through the main game interfaces, as shown in Figure 1 (left). The "practice" option helps students practice and improve their Arabic orthography before playing to enhance their confidence. When "play" or "practice" is selected, a window appears showing three levels: beginner, intermediate, and advanced (Figure 1 (center)). After the student selects the

appropriate level, he/she is prompted to select a sub-level, as shown in Figure 1 (right). Each stage consists of 12 levels. When the student completes a sub-level, the color of the corresponding star changes to gold. The student can choose an appropriate level, or is automatically moved to the next sub-level. At each sub-level, text is displayed, and the timer starts. In the beginner and intermediate levels, a spelling rule is displayed as a hint, as shown in Figure 2 (left). Next, the student must read the text and identify any misspelled words on the touch screen. A pop-up menu with three possible corrections is presented to the student, as shown in Figure 2 (center). The student must choose the correct answer, as shown in the text (Figure 2 (center)). Once the student presses "next," based on his/her time performance and ability to identify all of the misspelled words, he/she is moved to the next level; correspondingly, the timer and number of misspelled words are adjusted (Figure 2 (center)). The student can view his or her score or quit the game at any point, as shown in Figure 2 (right). The chart shows correct and incorrect answers in green and red, respectively.
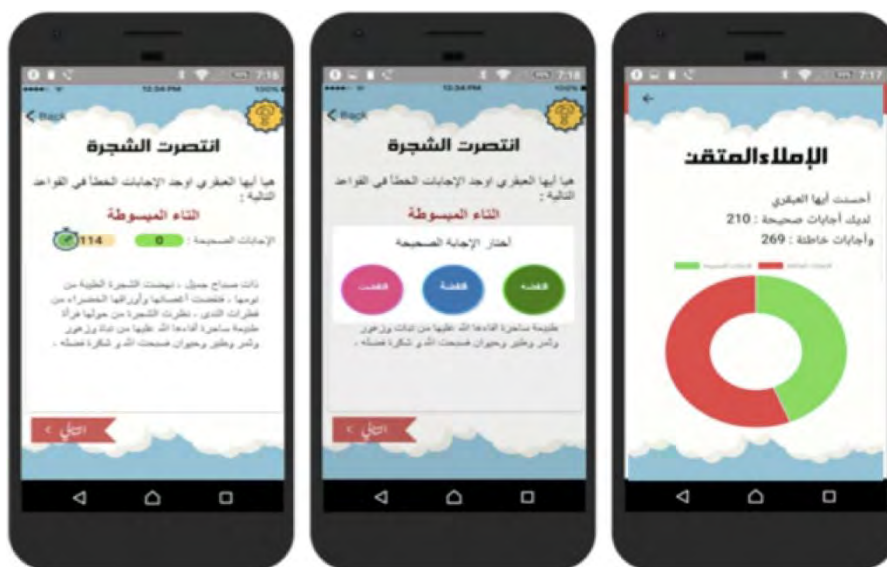

Figure 2. Mobile game interface

The GA approach is implemented to automatically adjust the number of misspelled words in each text and time limit based on students' performance. Specifically, if the student manages to find all misspelled words within a given time limit when they touch "next," the game automatically increases and decreases the number of misspelled words and time frame, respectively. In contrast, if the student fails to identify all misspelled words in the text within a specific timeframe, the game automatically reduces the number of misspelled words in the text and allocates additional time to the student. Several players piloted the game during the design phase. Ultimately, the timeframe was set to a maximum of 120 seconds, and the number of misspelled words was set between 3 and 15 to accommodate various student needs. No login was required at this stage. It is hoped that a log-in will be implemented in phase 2 of the game, where we can link the game to a server to enable teachers and administrators to monitor students' progress. For more details on the game implementation and design, see Al-Razgan et al. (2019).

Participants

In this study, the participants 52 female fourth-grade public school students aged 9–11 years. In Saudi Arabia, children enroll in public schools at the age of six years, and spend six years at the elementary level. Every school year consists of two semesters, each with at least 15 weeks of classes and a two-week examination period. The daily elementary school schedule has six 45-minute classes. Boys and girls from separate schools study the standard curriculum. Saudi primary education aims to provide general education and to enhance basic literacy and numeracy skills. Arabic reading and writing are taught from first grade until the end of sixth grade. Arabic orthography consists of 12 levels. These are taught to students both directly and indirectly by focusing on correct handwriting. When students reach third grade, they are expected to be able to read and write a simple paragraph.

Arabic language teachers usually review previous orthography rules to ensure mastery before introducing new rules. The traditional instructional approaches used in orthography teaching involve explaining orthography rules and extracting samples from a passage, followed by oral dictation. Among other methods, students can be given a list of words and asked to form complete sentences. However, traditional instructional approaches, such as textbooks and direct instruction, are usually criticized as ineffective (Abu-Rabia, 2013; Brosh, 2015; Taha, 2013). Therefore, it was hoped that the developed mobile game would provide students with an interactive and motivating learning tool for enhancing their Arabic orthography, i.e., by identifying misspelled words and correcting them in an enjoyable environment.

Procedures

The researchers approached a Saudi public elementary school at the beginning of the semester to obtain the required approval to conduct the study. The research aims and procedures were presented and discussed with the school's administration, who were assured that the collected data would be confidential and only be used for research purposes. After receiving consent from the school administration, two fourth-grade classes were suggested by the school's administration to participate in the study. These classes featured an adequate number of students (52), and were taught by the same teacher using the same instructional material. Next, the parents of the students were contacted to obtain their consent. They were assured that student participation was voluntary and that the data collected during the study would only be used for research purposes. In addition, parental approval was obtained to allow the students to bring their mobile devices to school, and to enable the researchers to take photographs for research purposes.

The researchers then met with the class teacher on several occasions to set up the study and discuss preparations. The classroom teacher had a bachelor's degree in Arabic from the Faculty of Education of a national university and over 20 years of teaching experience. She usually met the students eight times a week. Therefore, we decided to dedicate two of these eight sessions for game use. The study started at week 7 and ended at week 13 with 14 sessions, as shown in Figure 3.
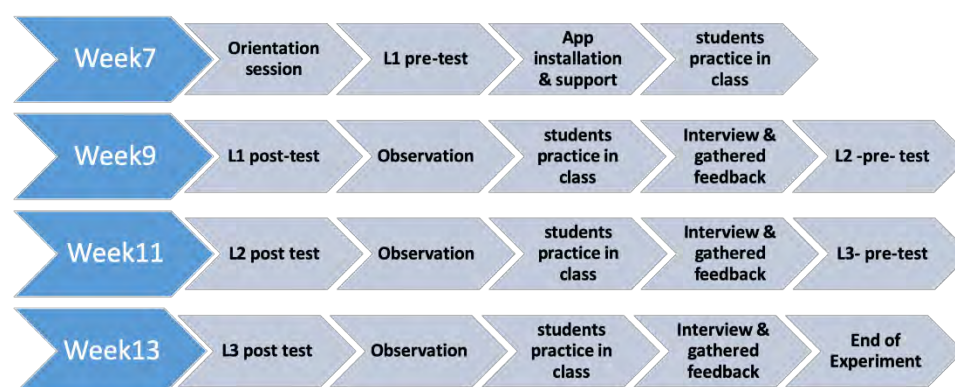
Figure 3. Study procedures

    The intervention began in week 7 with an orientation session. The researchers introduced themselves to the students and briefed them regarding the significance of their contributions and expressed their sincere appreciation for their participation. The orientation session also involved describing the game features and how to use them, and assessing the students in installing the game on their devices. The first session involved administering a pre-test to assess the students' performance before introducing the treatment. During the subsequent weeks, the researchers attended the classroom twice a week for observing the teacher and student and providing technical assistance when needed. The students were encouraged to bring their own devices and use them only during the Arabic classes. At the end of each class, the students 'devices were collected and kept with the teacher until the end of the school day. The researchers also provided additional devices. Although the students had the chance to choose which level to play, the teacher guided them to select the appropriate level based on the orthography rules covered during each lesson. Because logging in was not required, the students' progress was recorded manually (by the researchers) while using the application in a given lesson. At the end of each session, students were interviewed individually and in groups to discuss their experiences. In the sessions, the teacher usually began by explaining an orthography rule; then, she asked the students to play the game on their mobile devices (individually or in pairs) and to compete to attain the highest number of correct answers (see Figure 4).
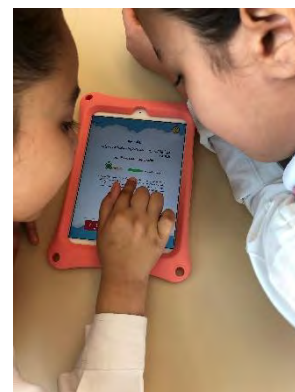

Figure 4. Students working on individual and pair tasks

Instruments

The pre-and post-tests were designed and administered with the goal of answering RQ1. As the game featured three orthography skill levels (beginner, intermediate, and advanced), three tests were designed to evaluate the student improvement over each stage, i.e., L1, L2, and L3. Each test included questions designed to assess Arabic orthography, as adapted from the Saudi Arabic language curriculum and revised and validated by three Arabic language instructors. The questions involved identifying and correcting misspelled words in a reading passage and writing the correct sentences. Each test was administered twice during the study, with two weeks between the pre-and post-tests. All participants had to attempt all levels of pre-and post-testing, and were compared statistically. Three instructors scored the pre-and post-tests using a unified rubric. The instructors gave similar scores, indicating an acceptable level of inter-rater reliability. The student scores were then analyzed to detect any skill enhancement at each level. The pre-and post-test scores did not affect the students' final grades.

To answer RQ2, classroom observations and interviews were conducted to collect data. The classroom observations involved note-taking regarding classroom dynamics, interactions, and discourses. After each session, the teachers and students were interviewed individually and in groups to record their views and perceptions. The interviews included questions on students' perceptions of the game and their attitudes towards using it. The classroom observations informed the selection of students for individual interviews. The interviews were semi-structured, as students were asked to describe any difficulties faced in a specific text or particular orthography rule, and/or to describe their feelings during class. By the end of the study, nearly 53% of the students had been interviewed individually at least once. The teacher was asked to elaborate on the challenges faced during class and to provide suggestions or concerns. The participants' responses were recorded and transcribed verbatim immediately after each session to maintain the accuracy of the data. The qualitative and quantitative data analyses and results are presented in the next section.

Data Analysis and Results

To answer the research questions, the data obtained from the pre-and post-tests for all three levels and interviews and observations were analyzed both qualitatively and quantitatively, as discussed below.

Pre- and Post-Tests

For the data analysis, the Statistical Package for the Social Sciences v.23 was used to conduct descriptive and inferential analyses.

The analyses included (1) calculating the means for the post-test and pre-test of the three measurements, (2) calculating the standard deviations to determine the homogeneity of the data for all tests; (3) calculating the dispersion measures (minimum and maximum); (4) performing a paired sample t-test to test the significance of the differences between the post-test and pre-test in the three measurements, and (5) calculating Cohen's d to measure the effect size of the impact of the mobile application on students' performance. The descriptive statistics for all measurements are presented in Table 1.

Table 1. *Descriptive statistics for all measurements*

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
L1_Pre-	1.00	10.00	7.067	2.530	-0.656	-0.539
L1_Post	2.00	10.00	8.259	1.872	-1.416	1.588
L2_Pre-	0.00	10.00	4.375	2.660	0.268	-0.665
L2_Post	3.00	10.00	7.615	2.037	-0.634	-0.673
L3_Pre-	1.00	10.00	5.563	2.451	0.244	-0.595
L3_Post	2.50	10.00	8.288	1.669	-1.120	1.308

The results from paired sample t-test used to test the significance of the differences between the post-test and pre-test in the three measurements are shown in Table 2.

Table 2. *Paired sample test results*

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
L1_Post - L1_Pre-	1.192	2.445	.339	.511	1.873	3.515	51	.001
L2_Post - L2_Pre-	3.240	2.769	.384	2.469	4.011	8.436	51	.000
L3_Post - L3_Pre-	2.725	2.154	.298	2.125	3.324	9.122	51	.000

The results from the paired sample t-test show that there is a statistically significant difference between the post-test and pre-test in the three measurements in favor of the post-test, which has a higher mean score (p < 0.05); however, the highest mean difference is 3.240 between (L2_Post – L2_Pre-), followed by 2.725 between (L3_Post – L3_Pre-). The least mean difference is 1.192 between (L1_Post – L1_Pre-), as shown in Figure 5.
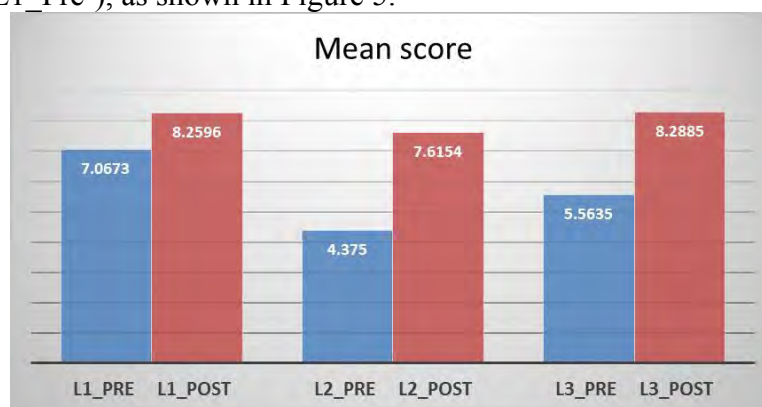

Figure 5. Mean scores for the three pre-and post-tests

Classroom Observation and Interviews

The classroom observation notes and interviews were qualitatively analyzed to assess students' perceptions of the mobile game use. The analysis involved a systematic exploration of the entire dataset, and attempted to identify noteworthy features that might establish a basis for recurring patterns. In addition, a set of initial codes was created using a data-driven approach, i.e., with no pre-existing coding framework or   analytic preconceptions. Next, we sorted these codes by searching for potential themes,   and collected all related data extracts according to the identified themes and sub-themes. The collections were then revised and refined to ensure internal homogeneity and external heterogeneity (Creswell, 2012). This analysis identified two major themes: attitudes/behavior and challenges/concerns. These themes and their sub-themes are summarized in Figure 6 and discussed in detail in the following section.
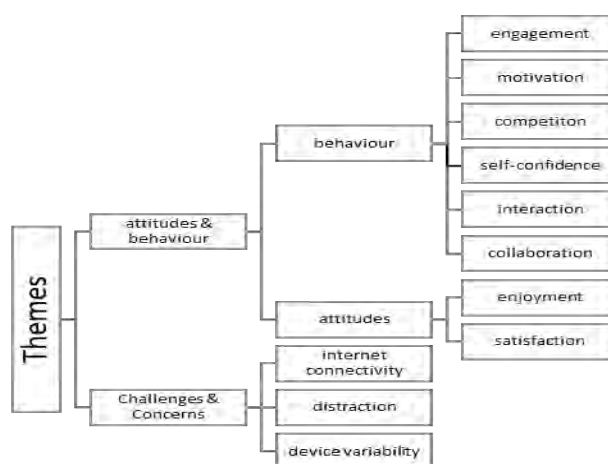

Figure 6. Themes and sub-themes from qualitative analysis

Discussion

This study investigated the integration of mobile games into a modern-day classroom learning environment, aiming to enhance students' Arabic orthography skills. Below, the study findings are discussed in the context of three categories: student performance, student attitudes and behaviors, and challenges and concerns.

Students' Performance

A quantitative data analysis of the student scores in Tables 1 and 2 revealed significant improvement in Arabic orthography following the use of the mobile game. The students performed significantly better in the post-test than in the pre-test for all three levels. Interestingly, the level of improvement was more evident at the intermediate and advanced levels. This can be linked to students' background knowledge, as most of them were familiar with basic orthographic rules from their previous education. Hence, most students achieved good scores on both the pre-and post-tests for L1. The significance levels were higher for the intermediate and advanced levels, potentially indicating that the game can facilitate the teaching of advanced Arabic orthography skills. These findings align with those of other studies; that is, significant improvements in learner performance are achieved when integrating mobile games into teaching and learning environments ((Prensky, 2001; Chaves et al., 2018; Bhide et al., 2019; Acquah et al., 2019; Sandberg et al., 2011; Ahmad,

Shaarani & Afrizal, 2012; Cho, Lee, Joo, & Becker, 2018). In all of these studies, researchers concluded that the integration of mobile games enhanced learning outcomes and had significant impacts on students' scores.

Students' Attitudes and Behaviors

The qualitative analysis revealed a positive attitude towards using the game among students. Furthermore, the classroom observations revealed high levels of engagement and motivation. On many occasions, students displayed considerable interest in practicing Arabic orthography using the game. A positive competitive atmosphere also developed, with students eager to achieve higher scores when completing the game and participating in the group tasks. It was interesting to observe the changes among the shy students. During the early sessions, these students seemed hesitant to participate in group tasks and preferred to play individually on their mobile devices; however, they showed more self-confidence in later sessions, and seemed more willing to participate in the group tasks. Studies have shown that mobile devices can create inclusive teaching and learning environments that engage all students, regardless of their abilities, backgrounds, or learning styles (Ciampa, 2013). High levels of interaction were detected among the students. They regularly discussed the game and Arabic orthography rules and assisted each other when encountering difficulties. The use of the mobile game appeared to allow students to develop their collaborative competencies, which positively impacted their learning behaviors. There were several instances in which they referred to their teachers or researchers for help or to check their answers. Most of the time, however, they interacted with their peers and discussed their progress. The interview data were consistent with these findings. During the interviews, most students expressed positive attitudes towards using the game. Almost all students reported that this teaching method was more enjoyable than the traditional teaching methods. Most expressed a wish to use the game in all sessions instead of only twice a week, reporting their excitement regarding attending class and using it. Many students reported that they continued playing the game at home and proudly demonstrated their progress to the teacher. Several students commented on how the game assisted them in understanding complicated Arabic orthographic rules and improved their reading. Some students reported that the instant feedback regarding their responses was constructive, and they perceived this feedback as an incentive for encouraging them to proceed to more challenging levels.

Such positive attitudes were reported in similar studies (Acquah et al., 2019; Al-Razgan et al., 2019; Niño, 2014; Koutromanos, 2020) i.e., that mobile games can be effectively integrated into language classrooms to attract students' attention and motivate them to focus on their learning. Yet, despite the students' positive attitudes, the data analysis revealed a recurring theme linked to the challenges and concerns reported by the participants, i.e., the teacher and students. Such challenges must be considered to ensure the effective integration of mobile games into teaching and learning environments, as discussed below.

Challenges and concerns emerged from the qualitative analysis. One of the significant challenges encountered in this study concerned Internet connectivity. Many researchers argue that Internet connectivity problems constitute a critical factor impacting free student access to resources (Hassler & Jackson, 2010; Haßler, Major & Hennessy, 2015). In this study, although each classroom was equipped with an Internet-connected PC, no WiFi connections were available.

It was necessary to provide an external router to enable all students to use the game, leading to interruption and frustration.

According to Khaddage et al. (2015), "schools often do not have an infrastructure for allowing an entire school population to access the Internet without adding costly WiFi access nodes." Teachers and students may find Internet access slow and frustrating, and these difficulties can waste instructional time. Another challenge was the possibility of distraction; on some occasions, students were observed using their devices to access other applications or to play other games during class. Additional supervision was also required as the students were freely accessing the Internet from their devices, and some students were tempted to access their social media accounts or to watch YouTube videos. At times, the teacher struggled to manage the students' behaviors and maintain their focus on learning. This is a common challenge associated with mobile learning (Uğur&Tuğba 2015). For the successful integration of this technology, research suggests that teachers should have supportive training programs focused on the pedagogy of mobile learning integration. Teachers must be provided with effective classroom management strategies to enhance their confidence in their instructional environments (Khaddage et al., 2015). Another suggestion for minimizing the distraction caused by mobile devices in a classroom is to provide a teaching assistant to monitor students and help keep them focused on class activities. Finally, the diversity of modern mobile devices, which have various screen sizes, can be a source of restriction for some students depending on the model and size of the device. In this study, some students used old mobiles that seemed slow and had low-resolution screens, as well as short battery lives. With smaller devices, the organization of working groups with more than two students was challenging, as these older mobiles seemed more suited to individual or paired tasks and were not appropriate for collaborative work.

Research suggests that the current affordability of technology will allow schools to provide a set of classroom mobile devices for promoting digital equality and minimizing technical challenges. Device variability is frequently identified as a factor affecting mobile learning integration (Haßler et al., 2015; Elias, 2020; Godwin-Jones, 2011). One limitation of this study is that it was conducted at an all-female school, and owing to cultural restrictions, it was impossible to include male students. Gender differences may be a significant factor affecting the study results; thus, further research is needed. Another limitation may be the duration of the study. As the study lasted only seven weeks, further research is needed to explore the long-term effects of mobile game integration on teaching and learning. Finally, as this was a case study with a relatively small number of participants, we did not attempt to generalize our findings to other contexts. Large-scale research is needed to enhance the generalizability of our findings.

Conclusion

This study explored the impacts of integrating mobile learning games on Arabic orthography skills among young Arab learners. The aim was to answer two research questions, as follows. First, what impact does the mobile Arabic orthography game have on elementary school students' performance? Second, how do Arabic elementary school students perceive this approach? The quantitative data analysis indicated a significant improvement in Arabic orthography skills among participants, especially for intermediate and advanced Arabic orthography rules. Furthermore, the qualitative analysis indicated an increase in students' engagement, motivation, and interaction.

The students reported that this teaching method was more enjoyable than traditional teaching methods. Many students reported that they continued practicing Arabic orthography at home using the game. These results have pedagogical implications for gamification in teaching and learning environments. Educators are encouraged to consider integrating mobile educational games into their instructional approaches, as they serve as a great incentive, especially for young students. Mobile games can be used to transform dull homework and classroom tasks into fun and exciting learning experiences. However, the findings also indicate several challenges and concerns that must be considered when planning to use mobile games in the classroom. Internet connectivity, device variability, and class management must be carefully addressed to ensure successful mobile game integration. We hope this research contributes to bridging the research gap on how to incorporate mobile gaming as an instructional tool into our classrooms, and how to enhance students' interaction and achievement levels. From a game design perspective, there is a significant challenge in designing and implementing instructional games that can promote learning while providing a fun, engaging, and immersive environment. Thus, our future work will enhance the game's instructional content by adding additional levels and increasing the number of passages. On the technical front, the next generation of the game will offer an offline edition, hoping to address the challenges reported in the study by allowing integration into classrooms with limited or no Internet access.

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