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Afaneen: The Design and Evaluation of an Interactive Mobile Game to Enhance Arabic Spelling

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Abstract: Spelling is an important skill for children learning to strengthen their knowledge of a language and enhance their reading and writing comprehension. However, many young Arabic learners nowadays lack spelling competency, which affects their overall learning process. Traditional spelling instruction, which is usually based on the rote memorization of words, has its drawbacks, and this might be one of the reasons for the incompetency. In addition, there is a paucity of technology-based aids for facilitating spelling skills tailored for the specific intricacies of the Arabic language. This paper describes the design and development of an interactive mobile spelling game "Afaneen". The application targets Arab students at the elementary and higher levels, and aims to enhance their Arabic spelling ability. In the game, the learner can listen to words and is required to type the correct spelling for these words in order to move to the next level. Immediate feedback is presented to the learners, and they can access the spelling rules at any time to check their understanding. To evaluate the usefulness of the spelling game, three evaluation approaches were used: a case study; think aloud sessions; and interviews. The results demonstrate an overall positive attitude toward the game, and reveal areas for further improvement and development.

Keywords: Arabic language, spelling game, Arabic spelling, Usability evaluation, Think-aloud protocol.
Categories: H.5.2, K.3, K.3.1, L.3.0

1 Introduction

Language literacy is an important aspect of child development. This process of acquiring language literacy in the early years of formal education mainly focuses on reading and writing skills, and these skills are then enhanced during middle school [Abu-Hamour, 13]. They require an adequate development of cognitive and psycholinguistic capabilities [Taha, 13], and are considered the foundation of academic success. Spelling is considered to be a foundation for the acquisition of reading and writing skills, and therefore cannot be underestimated. Spelling competency can be defined as the ability to remember, identify, and provide the accurate sequence of letters for any given word, orally or in writing, without encountering much difficulty. The acquisition of spelling competency overlaps with the development of the awareness of important aspects of the language, such as the "phonological, morphological, and orthographical structures of the language" [Abu-Hamour, 13], which affect the ability to read and express oneself. Spelling competency is therefore essential for a child to acquire in order to fluently master reading and writing abilities.

Recent research has shown that training children in phonological and morphological language awareness improves their word-level achievement in both reading and spelling. Because phonemes help children while reading or spelling unfamiliar words, insufficient training will result in slow progress of a child in reading and spelling [Taha, 16]. A good speller can spell with ease the words he encounters in usual writing practices and be able to spell unknown words based on the phonemes he hears. On the other hand, a weak speller usually has a limited vocabulary and would not be able to link phonemes with correct letters to spell new words. Therefore, the act of spelling can be considered a strategy, and it needs to be taught in early childhood [Graham, 81]. The process of spelling requires sufficient awareness of three main codes: phonological code, which relates to the sound of the spoken words; orthographic code, which relates to "coding and awareness of the letters in written words"; and morphological code, which relates to the "word parts at the beginning of the word that modify the meaning and at the end of the words that mark the tense, number, or part of speech." For example, the word "wanted" ends with "ed," which indicates a past tense. Thus, a learner is required to acquire the knowledge of many spelling rules in studying a language [Berninger, 08].

Researchers have argued which come first, reading or spelling, while training kids. The result in [Mohamed, Elbert, & Landerl, 10] has shown that spelling comes before reading because it is considered the pacesetter of the alphabetic phase [Mohamed et al., 10]. Spelling improves a student's learning and mental ability. As stated in [Berninger, 08], "Good spellers tend to be good readers, and poor spellers tend to be poor readers." The reason is that spelling shapes the child's conceptions of phonemes and sounds of the spoken words. Often, learning spelling rules and instruction improves the child's reading and writing skills as they move forward. Reading or writing alone cannot substitute for the ability to spell correctly. Children prefer to spell words as they hear them, rather than wait until the letters are connected for them to read these words. Furthermore, spelling places less burden on the child's memory as they spell what they hear based on their knowledge of the alphabet [Berninger, 08].

Because spelling affects reading, it also affects the writing ability. A child who feels comfortable spelling words can write better and can express his ideas using an abundant vocabulary. As suggested in [Treiman, 98], asking a child in the first grade to write once a day is a good idea. The child can benefit more if he is encouraged to guess the spelling of unknown words in his writing. Doing so will help the child spend more time writing on his own and less time waiting for the teacher's help. Children might also feel interested in using the spelled words they have just learned to write a story of their own. Berninger showed that better spelling ability at one grade level improves the writing composition at the next grade level. Therefore, spelling "relates to improved composition" in writing [Berninger, 08].

Thus, the ability to spell correctly is important for a person to express their ideas through writing. Further, while good spelling might be indicative of an educated person, poor spelling in writing can distract readers, appear to indicate a careless writer, and undermine their credibility. Recently, the prevalence of spelling errors has increased among the young generation, who mostly depend on technology. While software with spell-check features are widespread, young people still make mistakes in their homework and in social networking sites. These misspelled words could lead to misunderstanding the meaning of a sentence [Peterson, 05].

Considering the importance of spelling competency, several studies have attempted to address weaknesses in English language spelling among children, such as in [Graham, 81], [Berninger, 08], [Mohamed, 10], [Treiman, 98], and [Peterson, 05]. Recently, the issue has also been addressed for other languages, and in particular, Arabic [Taha, 16], [Erradi, 12],[Taha, 13], [Mohamed, 10]. Arabic can be described as “abjad or a consonantal orthography.” In the Arabic language, the problem of spelling mistakes is more apparent due to the difference between spoken and written Arabic. Arabic is therefore classified as diglossic, which refers to the use of two linguistic systems: one system is the Modern Standard Arabic (MSA) used in writing and formal communication, and the other one is the spoken system used at home and during conversation. These linguistic systems greatly differ in their vocabularies and phonemes. Children are usually exposed to MSA when they enter school, and they learn it as a new language to be able to effectively read and write. This gap in the languages burdens young Arab children and hinders their ability to progress because they are expected to acquire the new phonological and syllabic structures of the MSA [Taha, 13], [Taha, 16], and [Abu-Rabia, 06].

Additionally, Arabic spelling teaching usually follows the old system of memorization of the root-based structures of words. Even though some studies have attempted to provide intervention strategies to aid the learning of spelling, such as [Abu-Hamour, 13], these approaches however do not tap into the potential offered by modern technology. The author of [Abu-Hamour, 13] suggested a methodology to improve a child’s spelling ability, by practicing with a list of words first, spelling them while their teacher reads out these words, and then correcting the text by themselves. Although this approach has improved the spelling capability of Arab children, it does not leverage the benefits of modern technology. The use of technology with learning, known as mobile-assisted language learning (MALL), has recently included the enrichment of linguistic attainment. There are several MALL systems designed for the English language, but are very limited for the Arabic language [Erradi, 12]. Hence, more innovation is needed to improve the learning practices of Arab children.

While Arabic children demonstrate low confidence in MSA, and especially in spelling, this challenge could be made stimulating if it is weaved into a gaming platform embedded in mobile devices, since mobile phones allows access to features that cannot be found in traditional teaching, at any time and at any place. Furthermore, learning through the mobile phone can potentially reduce student anxiety and enhance student-learning ability. Furthermore, children love playing games and appear to learn more while having fun. This facilitates a change of attitude, and they become more enthusiastic as they play more. Hence, a child’s attitude toward Arabic spelling can be transformed with the use of new technology, especially that associated with gaming, and the creation of such technology for Arabic can address the shortage of MALL systems for the Arabic language, and in particular for spelling. Moreover, gaming can reinforce skill mastery during a spelling lesson or can be considered as an extra activity that a child does while at home. Such approach will result in an increase in the child’s spelling performance [Graham, 81], which is the aim of our app.

Therefore, according to the abovementioned factors, the objectives of this paper are as follows:

- To highlight the development process of an Arabic spelling game for Android mobile devices
- To describe the adoption of the most common Arabic spelling rules in the game stages arranged gradually from easy to difficult
- To conduct a case study to evaluate the applicability of our system using three approaches: holistic test case scenario, think-aloud sessions, and interview sessions.

The remainder of this paper is organized as follows: Section 2 presents the literature review divided into three areas: spelling games, Arabic orthography, and spelling applications. Section 3 illustrates the Arabic language in terms of its importance, challenges, and difficulties. Sections 4, 5, 6 and 7 describe the architecture, design, and implementation of the Afaneen mobile game, and Section 8 presents in-depth evaluations of our game. Finally, Section 9 concludes the paper with a discussion of our future work.

2 Literature Review

Recent research has focused on spelling literacy and its effect on the reading and writing ability of children. In this section, we describe some of the related works that tackle spelling and language orthography. This section is organized into three parts: (1) description of spelling games; (2) presentation of some studies related to the Arabic language and its spelling skills, (3) mobile assistive language learning (MALL) and (4) presentation of a few smartphone applications for spelling enrichment.

2.1 Spelling Games

Incorporating games in the teaching lessons have been attractive for learners and instructors. Physical games to help students acquire learning materials have been around for a long time. Games tend to be more effective than passive listening or watching at providing a deep cognitive understanding of the subject. These games are usually used to review or enhance certain skills that have been taught using a regular method beforehand in classroom lessons [Petri, 16]. Games can also highlight spelling lessons and enhance spelling performance. The acquisition of spelling skills depends mostly on the student’s attitude and motivations. Therefore, the authors in [Graham, 81] suggested sensible use of games and special devices. They listed 95 games and activities to enrich the student spelling skills. They listed the games as follows: title of the game, description of the game, and an example or illustration to describe how it can be applied by students. These games are well described for use of interested teachers who desire to implement or modify their spelling program. They can help students in “phonics, vocabulary development, dictionary, imagery, proofreading, and other word study skills [Graham, 81].”

Additionally, the author in [Lussiez, 85] patented his idea of a spelling game that was based on randomly selecting a word from a repository of words. A player spells the words and gains points on correctly spelled words, and loses points for incorrectly spelled words. The process starts with the first player selecting the game level. Then, a random word is selected and pronounced, along with its definition, by the second player. All players, except the second player, spell the word. A player gains points if she correctly spells the word, and loses points otherwise. The process continues, allowing each player to be the first player. The invention aims to inspire the players to simultaneously obtain high scores in the game and to teach them spelling.

The previously described activities can be undertaken in a classroom setting and can be designed and controlled by the teacher. As technology evolves, spelling games also advance. For example, the authors in [Dekel, 07] developed a prototype of a well-known ABC spelling-block game by embedding an easy-to-use interface with computational functionality. The aim was to help young children with their word spelling and to obtain immediate feedback. A child tries to combine letters to create a word. If the word exists in the dictionary, the blocks would display a green light; otherwise, a red light is displayed. This game provides immediate multimodal feedback to help the child remember the word he just spelled. The authors in [Dekel, 07] built a hardware system of blocks with a dictionary to check if the created word exists in the dictionary. Their prototype consisted of several blocks in which each block represents a letter, and the main block, named as the smart block, contains the power source and processing unit. They tested the system by employing five children, where the children immediately recognized its functionality and played it. Moreover, the children were very happy when the LEDs turned green and they received an instant response.

Along similar lines of using technology, the authors in [Howell, 09] designed BuzzWord, an assessment and interactive word-play game built on a corpora and embedded into a tutoring system. It is based on falling words on a screen, and the player tries to fit them in the best possible way over a stack of given words. The target audience is English-speaking children aged from 11 years old and above. It is a word-stacking exercise. If the player can combine the falling word with the intended word, he will receive a bonus score. Each word individually appears and falls down, and the player must pile it to a compound term already available in the playing area to collect a bonus, and the word then disappears. Otherwise, the word is frozen and cannot be moved. Complicated terms received a higher score than common terms. The compound terms were collected from WordNet after various filtrations to build the necessary school terms for the designed game. It comprised student and tutor modules. The student module was “designed to record and analyze the decision made by a player during a game.” It was aimed to build the student’s knowledge and skill. This module is connected to the tutor module to determine the level of difficulty of the game. The tutor module displays the assessment of the student’s progress in the game. BuzzWord is a computational linguistic game based on compound words gathered from WordNet. The tutor chooses a list of words based on the subject of his choice. The game does not directly involve spelling, as it is based on words and not on letters, and it has not yet been evaluated using real players.

2.2 Arabic Orthography

From the perspective of the educational approach, the early years of students’ Arabic reading and spelling acquisition pose significant challenges. The nature of Arabic orthography necessitates much consideration on how children should learn to read and spell because, as mentioned earlier, the spoken and written styles are not the same. Researchers have investigated Arabic orthography in further detail. The author in [Taha HY, 2013] addressed how the orthographic and linguistic uniqueness of Arabic language have affected the reading and spelling skills of Arab children. The author illustrates the differences between spoken and written Arabic text, which underlines the importance of phonological processing skills of written Arabic for the spelling ability of children. The author also discusses the need for morphological and visual processing roles while reading and writing, especially among young children. He demonstrates the importance of the role of phonemes in MSA to improve the reading and spelling ability of the youths in elementary schools. He then points out that most words in both the spoken and written styles in Arabic are based on a root, which usually consists of only three to four letters. An adolescent familiarity of the Arabic roots can be a significant aid in the spelling of words. Thus, the understanding of orthographic representations, along with writing rules, can result in greater accuracy in reading and spelling.

Additionally, the same author in [Taha, 13], together with Saiegh-Haddad, jointly investigated in [Taha, 16] the effect of two linguistic intervention programs, phonological and morphological programs, on Arab youngsters on their spelling progress. In three grades in elementary school, i.e., second, fourth, and six grades, children were trained for six months in a school year from November to May. The authors selected the children based on a spelling test and subsequently based on a reading test to identify the skilled students apart from the poor students and to prepare them for the experiments. Their language teachers assisted in the assessments. The researchers divided the students into three groups, namely, skilled, poor, and control groups, to measure their improvement between the pre- and post-test spelling scores. They conducted their experiments on 289 children and students in each grade that were randomly divided into three intervention (phonological, morphological, and control) groups to test their performance twice during the pre- and post-spelling tests. The two intervention groups were trained for phonological and morphological skills respectively, whereas the control group received ordinary reading and spelling instructions. The results showed significant improvements from the pre-test to the post-test in the intervention groups. However, no differences in the score were observed in the control group. In addition, significant improvements in the spelling results were demonstrated by the skilled readers as well the sixth-grade students. These findings imply that a traditional spelling lesson alone cannot enhance the student’s spelling skills, and therefore additional efforts are needed supplement the traditional spelling programs. This finding can be a valuable aid to educators who are planning, implementing, or modifying their spelling programs.

In a similar manner, the authors in [Mohamed, 10] studied the development of reading and spelling skills among young Arab children in Grades 1–3. Their aims were to formulate evaluation measures for reading and spelling tests, discover the relationship between reading and spelling, and test whether any gender difference manifests among young children. The researchers conducted experiment on 111 students randomly selected from private schools in Egypt. The experiments were performed during the school year for a period of three months. They carried out spelling and reading tests to identify the poor, average, and good students. The students were given practiced items before the reading test. The test was a 1-min reading test of 136 words where the students read aloud the words and were graded based on their reading. The spelling test was based on the selected sentences read out loud, and the students must write the specific words as instructed. Subsequently, the sheets were collected and graded. Overall, the study indicated statistically significant differences among the three grades, and higher-grade students outperformed the lower grade ones; no gender difference was observed. More interestingly, the authors showed that fluent reading skills eventually develop with age after spelling skills have been acquired by a young student, which implies that adequate spelling skills are developed before fluent reading.

The study by [Erradi, 12] probably offered the first Arabic spelling and vocabulary game. The authors developed an m-learning application called ArabicTutor, which is an interactive game, to learn Arabic spelling and vocabulary. It was organized into packages that consisted of a list of words, their definitions, sample sentences, and multimedia content of photographs. It is similar to the SpellingCity[1] website that teaches English vocabulary and spelling. It consists of two primary parts, one for the teacher and the other for the learner. It also uses existing available tools for Arabic natural language processing for preparing the contents. First the teacher chooses a list of words to be learnt. Then, the systems collect the definitions and sample sentences from machine-readable dictionaries and Arabic corpora to help the students learn spelling and enrich their vocabulary. In addition, the system provides additional supporting materials such as stemming, part of speech tagging, text-to-speech conversion, and diacritization. The second part is for the learner, where he can choose a package, download its resources, and learn it during his free time. The system can also provide further game activities for the learner, such as shuffling the words of the sentences and asking the player to arrange them. A spelling test is also provided where the system reads a sentence word for word and asks the learner to write it to check his spelling. In addition, it provides a matching game based on the definition of a word and appropriate sentences. It is a complete system that stores its content on the server and has an interactive interface for touch-based devices. Nevertheless, the system has not yet been fully implemented for testing and evaluation with actual students, which the researchers intended for future work. Although it is an exciting game, it still needs to be validated.

2.3 Mobile Assistive Language Learning (MALL)

Recently, mobile learning has gained significant attention among researchers, which has enabled trends in research to move from small case studies to large projects nationally and internationally [Sharples, 13]. Among these studies, a few exist in the field of teaching and learning, and especially language acquisition. Several studies have been conducted on the use of handheld devices to improve language learning, as presented in [Kukulska-Hulme, 05], [Sharples, 13], [Ally, 09] and [Petri, 16]. Furthermore, mobile games are spreading widely among young generations; some of these games are designed for educational purposes while others designed for entertainment. Among them are the games that deal with language ability and advancements. As stated by Chen, the purpose of a language game is to “use the language." These games try to nudge the players to use the language in the correct way. They aim to increase players' productive and accessible language skills [Chen, 05].

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[1] https://www.spellingcity.com/

Educational mobile apps are becoming popular among students with their relative portability and ease of access anywhere and at any time [Rico, 15]. Moreover, learning via mobile games allow students to acquire knowledge through trial and error, which follow the theory of cause and effect, where the learner changes his behavior based on his learning curve. In such a scenario, players feel comfortable making mistakes and try more often to get the correct answers. These kinds of games can be suitable for language learning skills like vocabulary development, spelling, listening, and reading [Keyes, 16].

The author in [Keyes, 16] developed an English vocabulary app that improves players' English language skills. The game provides definitions of words, and the player needs to guess the correct words. It is similar to a paper based crossword puzzle, but in an apps format. The game is based on the solving of a crossword grid. From a pedagogical perspective, it allows the players to review various vocabulary definitions to reinforce the learning of new words. It also, provides a reward for the correct answer as the player progresses through the game's difficulties, to motivate the player and acquire a precise vocabulary. This game reinforces "frequent repetitions of learning activities."

2.4 Spelling Application

A large number of mobile applications have been developed to promote spelling and vocabulary skills. Additionally, the table below lists some of the available applications designed to strengthen language literacy outside classrooms. Our choices of the selected applications were based on the high rating and number of downloads these applications have obtained.

Game Name	*Game Idea*	*Difference from Afaneen*	*Arabic*
Arabic Crossword Game: An android game based on the idea of crossword puzzles, which appear in old newspapers. The aim of this game is to increase knowledge and stimulate search. The selection of this puzzle is based on the general information in various fields, and it is suitable for all ages [Alrazy, 15a].	The player needs to figure out the mystery behind each question to correctly guess it and select the correct letters. It divides the grid into several groups, and each group questions have different words or phrase puzzles. The questions vary between easy and difficult ones, and the letters of their answer intersect in which each joint has a single or more characters to easily determine the answers to the questions.	-It is designed for entertainment and not for pedagogical learning -It covers general topics including those not concerned with spelling -It is not based on writing rules -It does not contain levels to move the player from easy to advanced stages	Yes
Names of Allah: This game is considered a fun game that teaches children the names of Allah. It is fascinating and exciting and helps children learn the Arabic language while	It is based on writing the names of Allah, and consists of catching letters by moving the iPad left and right. It is a fun and interactive game that uses various sounds to make it attractive to children aged 3–13 years old.	-It is based on teaching the young children Allah's names (vocabulary, not spelling) -It does not have levels or stages to	Yes

playing. The game is developed for young people [Love my Lord, 16].		motivate the players -The interface is designed for young children	
Game Password: This game is based on the old style of crossing words in a grid, found in newspapers and magazines. Difficulty in this game depends on the question given to decode the password at the end of each stage [Alrazy, 15b].	The player has to find the scattered words in the grid and write them off. In the end, a character set remains where the player must know the code to decrypt the password. This game is meant to be played in a relaxed setting. Phases are carefully built to cover a certain topic for each puzzle, to increase the suspense. In each section of the stages, the player should discover the words by himself.	-No time or points are given -It has dozens of stages -The player must discover the word by himself to decode the password at the end of each stage -It is designed for adults to guess words, rather than for learning spelling or increasing vocabulary knowledge -The stages are similar in terms of their challenges and difficulties -It is not free	Yes
Crossword 2015: This game is an entertaining and educational game that is full of Arabic words. It helps in remembering how to spell the characters. A coin is awarded in some letters to increase the challenge [Abuhamdan, 15].	In this game, spell checking is indicated by colors (a red color indicates wrong spelling, blue means the word is duplicated, and green means the word is correct).	- On of the biggest disadvantages in this game is that no increase is given in the levels of difficulty among different stages. -It is not based on spelling rules	Yes
Treasure Game: An Android game in which moving from one stage to another is represented as moving to a new island to find the treasure [Alrazy, 15c].	The player travels across the ocean to search for words in each puzzle and use all available letters to build words and solve the puzzle. The stages of the game become more difficult as the player moves forward. The player can use the carrot available as a hint to solve difficult words. Moving from one stage to another is represented as moving to a new island to find the treasure.	-The stages in this game are very long, which can easily tire a player -It is not based on spelling rules	No
Four Letters: In this game, four-letter words are given. It presents many words consisting of four letters to make it more attractive [Four Letters, 15].	It displays four letters, and a player has to create a word as quickly as possible. The score increases if the player creates more words. The difficulty increases the longer one plays. However, a player is given a limited period of time to guess the correct words, or she/he loses.	-All levels are the same -It is not based on spelling rules but simple guessing of the four-letter words -It is not free	No
Kalemat: The first crossword game puzzle	The game consists of 34 stages from a variety of categories	-The time provided is not suitable for	Yes

that supports both Arabic and English. Kalemat is both an entertaining and educational puzzle [Hudaifa, 14].	(forms, sport, business, law, constitution, etc.). In the Kalemat game, one can play every stage in Arabic or English or can play it using mixed languages where it displays words in one language and the player finds the translation in the other language.	the task -There are no levels -It is not based on spelling rules	
Search for Words: This game is an interesting game that supports Arabic and English [Jabareen, 15].	The idea is taken from the old crossword puzzles in newspapers. The player searches the given word from the completed sentences. It is displayed on a black board, and the correct words are colored white. A timer checks the answer	-Many letters are given, making word selection long -It is not based on spelling rules	Yes
Hear & Spell-Spell Challenge: It is a simple and fun educational game designed for students of all ages. The difficulty progresses from easy to medium, and the last level consists of difficult words [Hear & Spell, 2017].	The aim of the game is to improve spelling skills and enrich vocabulary. The player listens to the pronounced word and then types the correct spelling. This game has five levels. The first level contains mostly misspelled words with 25 stages, and each stage has 14 different words. The second level contains the top 1000 words.	-The user interface is not attractive and difficult to use -It is not based on spelling rules -It is not free	No
Lets Spell: Learn to Spell: This game is a great and fun game to practice English spelling and learn new vocabulary. It is ideal for all ages [Lets Spell].	It is based on an image associated with each word in Spanish and English to promote language learning. The game lets the player pick the desired level of difficulty at any time, and the language that they need to improve in. The "easy" level allows little kids to learn how to write. It has over 500 words to spell and three difficulty levels. It has a simple layout and very intuitive and beautiful illustrations.	It is not based on spelling rules	No

Table 1: List of Spelling Applications

3 Arabic Language

From the above research and applications presented in *Table 1*, there seems to be a lack of projects that aims to enhance Arabic learning and acquisition through employing mobile technologies. Therefore, we noticed there is a need for more applications to support Arabic spelling learning. Our project Afaneen will be one of first mobile apps that enhances the writing communication of players, by reviewing the most popular Arabic spelling rules in an easy and accessible way in the player's own mobile phone.

3.1 Importance of Arabic Language

Arabic is one of the most popular languages and it ranked among the top of languages in the world. More than 260 million people throughout the world speak Arabic. Moreover, it is the main language in most of the Middle East. The spread of the Arabic language began in the seventh century during the Islamic conquests, which expanded the Arabic nations from the Middle Eastern countries into Northern Africa [Ahmed, 10]. Many scholars who are not native Arabic have published great books in Arabic, such as the "astronomer and encyclopedic scientist al-Biruni and the philosopher and physician IbnSina" [Ahmed, 10].

As stated previously, Arabic is a Semitic-developed language and became one of the major languages of the world [Hasanuzzaman, 13]. The Arabic language consists of 29 consonants and eight vowels, and the written texts in Arabic are "primarily consonantal with the short vowels being superscripted." Additionally, Arabic letters differ in the their cursive writing forms depending on whether their position is at the beginning, middle, or end of the word [Mohamed, 10]. Furthermore, the letters are divided into categories based on their shape, and dots are placed at the top or bottom of the letter [Taha, 13]. In addition, the Arabic language has three forms of grammar: singular, dual, and plural. The Arabic language is very rich in vocabulary, and it has, for example, "52 synonyms for darkness, 34 for rain, 16 for moon, 21 for light, 164 for short, 91 for long, and 50 for cloud." [Ahmed, 10] Nonetheless, Arabic is like any other language with its own complications in modern society.

3.2 Arabic Language Challenges and Difficulties

A complication in the Arabic language is the fact that it depends on three short diacritics that each result in different consonant–vowel pronunciations. For example, letter /k/ can be pronounced as /ka/, /ki/, and /ku/. However, these diacritics are usually not written, and the reader or speller needs to infer the pronunciation from the context of the sentences. Further, Arabic letters have similar graphemes; however, their phonemes are completely different, such as the letter (خ، ح), which makes it difficult for beginners to master and correctly spell [Abu-Hamour, 13].

Similarly, the most significant issue regarding young children learning Arabic is the fact that it is, as considered by scholars, a diglossic language. Diglossia is defined as the phenomenon in which where the spoken and written forms of a language are different in terms of vocabulary, syntax, and grammar. A pre-school child can speak the language to a certain extent and style. However, when he enters school, he has to learn a new and unfamiliar language. This issue is problematic for both young and adult non-native speakers owing to their lack of ability to practice the written language as they verbally communicate with other people [Abu-Hamour, 13]. Additionally, modern society has also affected the Arabic language.

Globalization has affected individual identities. As a result, it has affected the economy and spread cultural globalization, especially with respect to languages. In the Middle East, the use of other languages is quite significant, such that of English in work and study. This has led to the marginalization of the native language, Arabic, which has been "relegated as non-useful." Furthermore, a negative outlook on the Arabic language and the positive outlook on English has made foreigners unwilling to learn the Arabic language. The multiplicity of accents in the Arabic language and colonization by some countries lead to the difficulty in understanding the classical Arabic language, especially by children [Ahmed, 10].

Remarkably, Arabic has been statistically shown as one of the most spoken languages around the globe [Most, 14]. However, this has not transferred significantly to the Web. Arabic has been laid off where more emphasis on English has taken precedence in many aspects in life. Additionally, individuals whose native language is Arabic have felt that their language is downgraded. Further, they felt "lost." [Ahmed, 10] Consequently, the problem of the Arabic language speaker must be seriously addressed. Language is an important asset in society and culture, and it has been stated that it is an "ultimate measure of human society" as well as "the light of the mind," because with language, one can verbally communicate and express ideas, thoughts, and cultural ties [Ahmed, 10].

4 Afaneen Game Discussion

Previous research indicated that Arabic speaking children have a low fluency rate in learning the MSA, especially in spelling [Mohamed, 10]. Hence, several research proposals were presented to overcome this problem, such as intervention testing among elementary students. Spelling lessons alone are insufficient as a learning tool, and extra efforts are needed for program reshaping.

We also need to note that Arabic is among the more frequently spoken languages. However, native Arabic speakers usually miss important orthographic rules. To address this, a master Arabic language student has compiled the most common spelling rules into one booklet that was freely distributed online. The booklet consists of rules, definitions, and examples and teaches how to distinguish these rules from similarly written rules, such as the differences between (ة، ه) (ة، ت) (ا، أ) and other important rules in writing [Alktheeri]. The booklet presents the materials in easy-to-read-and-review manner and is full of colored illustrations. The booklet is suitable for all ages and can be used as a supporting material in writing. However, it does not replace the spelling lessons in school nor can it be used as a single source.

On the other hand, in spite of much knowledge on the struggles faced nowadays by the Arabic language and the recent research that focuses on Arabic linguistic issues, several reforms toward teaching spelling lessons are very much needed, as suggested by numerous authors. Efforts from school are insufficient to make the youth proud of their native language; thus, this becomes the responsibility of society as a whole. In the new global economy, technology has become a central issue for learning and teaching. From this perspective, our project has made use of the booklet's [Alktheeri] spelling rules. We also consulted an Arabic language teacher to arrange the spelling rule from easy to difficult to embed and select the appropriate words for each rule. Thus, a mobile game was considered to integrate these common spelling guidelines [Alktheeri] in a fun, entertaining, and challenging game, which is named as Afaneen, similar to the title of the booklet. Throughout this paper, the term Afaneen will refer to our spelling game.

Afaneen employs a simple gradient backdrop for the playing area. The prototype implementation incorporates most of the spelling rules. The main screen includes a list of letters with easy-to-read fonts and without any garish background image that distracts the players from the game. The effects are felt when the user begins the game, selects the letters for the pronounced words, and collects points for the correct words, and it produces an error sound if the player errs. Several iterations of the design are implemented for the target population aged 10 years and above to select the appropriate background color and for easy understanding of the selected level.

In the next sections, we describe the design of the game and implementation of the Afaneen system.

5 Afaneen Game Architectural

In this section, we describe the Afaneen architecture, which consists of the system architecture diagram; use case diagram, and class diagram; and Afaneen design.

Afaneen is a single-player real time android game app that runs on top of the android phone OS.

The user input is a touch event captured by the application. The game logic checks the input and then outputs the corresponding sound for the correct or incorrect input as shown in *Figure **1***. In our project, we used an Android software development tool. The game architecture on Android mobile devices consists of the user input, game logic, audio, graphics, and output.

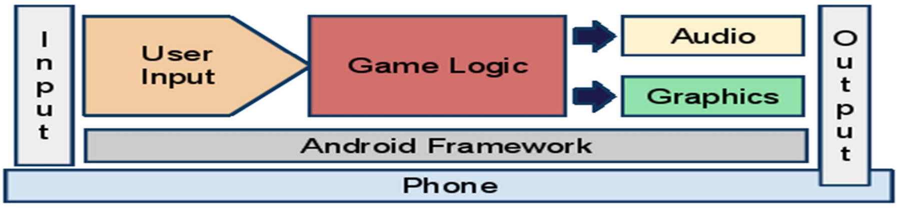

Figure 1: Game architecture on an Android phone borrowed from [Jano, 10]

User Input consists of the device touch screen and movements that interact with the game engine to monitor the touch event. The game logic is responsible for changing the state of the objects in the game according to the player's actions (input letters), and checks whether the input word is correct or not within the given time. Based on its result, the audio module produces sounds for the current state of the game (winning, losing, and time up). The graphics module is "responsible in rendering the game state on the display [Jano, 10]." It displays the necessary frames for the specific times that they are allowed to be displayed, and moves to the next word or level. The output is a combination of sound, image, and vibration [Jano, 10].

To further illustrate the design of Afaneen, we include the Use Case Diagram in Figure 2 showing the different functions and actors involved with the system. For our app, there is only one user, 'the Player', and the player can perform these actions: Play game, use coin (remove one letter from the list of characters as a hint for the user), pause, continue (allow the player to continue the game after a pause), quit, get help (allow the player to view rules related to the current level), view level (allow the player to view the current level), display statistics (allow the player to display her statistics), reset statistics, view last mistakes (view previous mistaken input words and the correct answers), and finally contact us (via email, or twitter account).

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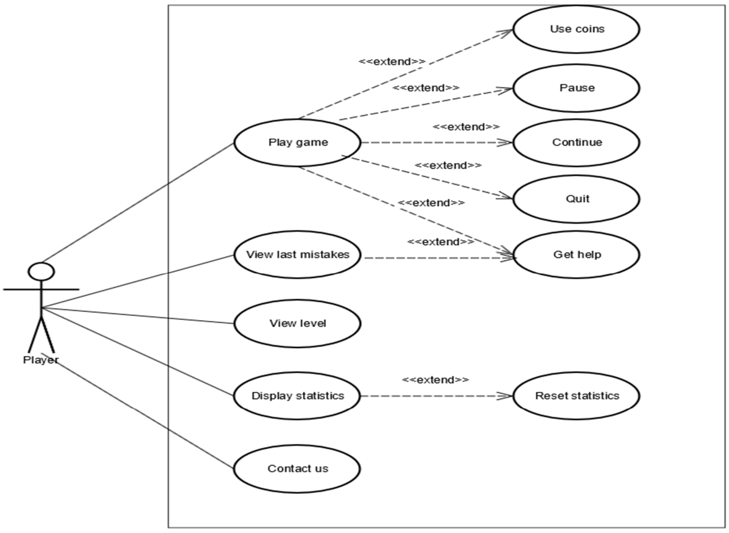


Figure 2: Use Case Diagram

We also include the Class Diagram in Figure 3, which shows the different classes used in the implementation of Afaneen, and how they communicate with each other. The class diagram represents a prototype of main classes, fields, methods, and the relationship between these classes. The game applications consist of the following classes: game, player, level, statistics, mistakes, help, and database. Once the player starts the game, the system retrieves the stored contents, which are the pronounced words and their associated spelling rules. Then, the game starts at the first level and reads the associated word for the player to spell. If the word is correctly spelled at the first attempt, the player gains two points, which are added to the player's coins in the statistics class. In addition, a clapping icon is displayed as an encouragement and to keep the player engaged. However, if the player cannot correctly spell the word, he can use the "help" function to display the spelling. The player can quit the game at any time, and the system records his level for display when he returns to play again. The game does not require an Internet connection. Instead, it locally stores the data in the mobile device, as connecting to the Internet requires a subscription, which is not always possible for young players. Once the player finishes one level, the system will display a pop-up message congratulating him on his achievement and display the spelling rule that he has just mastered.

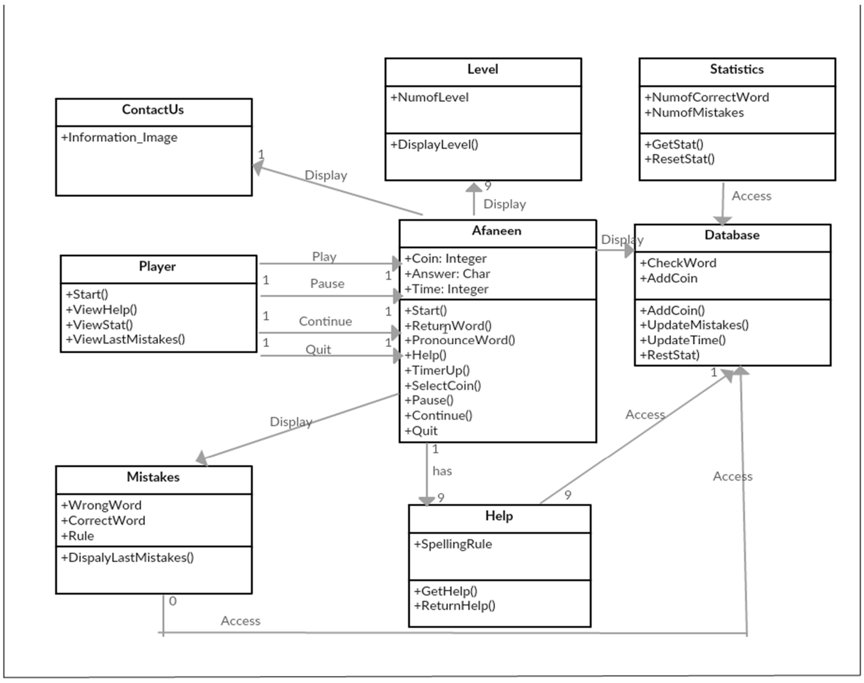

Level
+NumofLevel
+DisplayLevel()
Statistics
+NumofCorrectWord
+NumofMistakes
+GetStat()
+ResetStat()
ContactUs
+Information_Image
Display
Access
Afaneen
+Coin: Integer
+Answer: Char
+Time: Integer
+Start()
+ReturnWord()
+PronounceWord()
+Help()
+TimerUp()
+SelectCoin()
+Pause()
+Continue()
+Quit
Database
+CheckWord
+AddCoin
+AddCoin()
+UpdateMistakes()
+UpdateTime()
+RestStat()
Player
+Start()
+ViewHelp()
+ViewStat()
+ViewLastMistakes()
Play
Pause
Continue
Quit
Mistakes
+WrongWord
+CorrectWord
+Rule
+DispalyLastMistakes()
Help
+SpellingRule
+GetHelp()
+ReturnHelp()
has
Access
1
9
0

Figure 3: Class Diagram

6 Afaneen Game Design

The main goal of this project is to design and develop an Arabic spelling game that allows a player to practice and review most of the missed Arabic spelling rules. This section describes the app features, and the Game Design Document (GDD).

6.1 Features

The main features of the Afaneen system are the following:

- Allows the player to perform and practice
- Allows the player to review the spelling rule for each level
- Allows the player to collect coins by correctly writing the spoken word within the time frame
- Allows the player to check previous mistakes
- Allows the player to listen to the pronunciation several times

6.2 Game Design Document

In this section, we describe the details of the Game Design Document (GDD) for our game Afaneen. A GDD is a very important part of game development as it describes the overall vision for the game. This includes the game overview, gameplay, mechanics, story, levels, interface, and technical aspects.

6.2.1 Game Overview

The game overview gives an overview of the game concept, look and feel, and the game scope.

6.2.2 Game Concept

The objective of the Afaneen game is to teach the correct spelling of Arabic words in an easy and fun way, based on hearing the spoken words and attempting to type in the least time possible. Each level focuses on spelling different words that are organized from easy-to-advanced Arabic spelling rules.

The story for the concept our game is very simple. It is about Sara, a thirteen year old girl and a secondary school student, who finds herself struggling with Arabic spelling. Sometimes, she has difficulty spelling common Arabic words correctly. She is used to playing games on her tablet-devices and phone; therefore, she likes to learn through playing. As a result, the Afaneen game was designed to address her needs. Sara must select the correct letters in the right order to write the word with the correct spelling. If Sara spells the word correctly within the time limit, she will gain 2 points. However, if Sara makes a mistake by selecting a wrong order of the letters; she has more chances within the specific time limit at each stage. If the time elapses, the game will produce a warning sound and start over by pronouncing the word again. Additionally, our game is a fun and educational game that gradually moves the player from easy Arabic spelling rules to more advance rules.

6.2.3 Look and Feel

Afaneen provides a user-friendly interface. The interface consists of icons and text, rather than text-only buttons, to make it easy for young children to select. In addition, we used consistent interface light colors. The game consists of two levels of hierarchy. The first level is the home level, and the second consists of: game, levels, statistics, and view last mistakes. The game plays sound effects when the user clicks a button, earns points, enters incorrect letters, or wins a game.

6.2.4 Game Scope

Afaneen is an educational game, which teaches Arabic spelling rules in an attractive manner to improve the writing ability of Arabic words. Our target audiences are users aged 10 years and older. They should be able to read and write, know how to use Android smart phones, and do not experience any physical or learning disability (LD). The language used for the application is Arabic. The main user interface is comprised of: spelling levels (consists of 9-spelling levels organized from easy-to-difficult), statistics of the games (show the players' total score; play time and the number of corrected words.), last mistakes (all the player's mistakes and corrected words with related spelling rules). Moreover, player can view the spelling rule for each level while playing, in order to review it and try not to miss any words.

6.2.5 Game Play

The level starts with the pronounced word, and the player then presses the correct letters to come up with accurate spelling of the words. The given letters consists of the four most confusing letters for each rule, besides the letters of previously heard words, such that for each word ten letters are displayed, in order to make the game challenging. Also, the players will be given a time limit to answer. They are also able to listen to the word again or view a hint when needed.

6.2.6 Game Mechanics

Game mechanics describe both the implicit and explicit rules of the game. It is the model of the paradigm in which the game operates.

- The game is organized from easy to advanced spelling rules without explicitly informing the player
- For each level there are three chosen words that are selected carefully from commonly mistaken words
- For each spelling rule, there are some confusing letters that are added and displayed randomly for the pronounced word to trick the player. These were selected with the intention to address the need of the game to improve Arabic spelling.
- The player cannot unlock any stage unless she is successful in the previous stage.
- The player collects 2 points for each accurately spelled word, and then can use these points to reveal some letters in the advanced levels.
- Incorrect words, along with the correct words associated with spelling rule, will be available in the previous mistakes button in the main menu. This is to facilitate learning by comparing mistakes with the correct words and hopefully avoiding them in the future.

6.2.7 Game levels

There are three distinct words in each level chosen according to the Arabic spelling rule. A level consists of the main rule the player gets to answer, and there are correct, wrong, and confusing letters scattered across level randomly. The correct letters differ in each level according to its spoken word. Moreover, we have a timer in our game that starts running as soon as the word is pronounced. We used it to calculate the score received by the player, depending on whether she gets the word within the given time or not.

6.2.8 Game Interface

The heads-up display (HUD) consists of the elements that are displayed on the screen during gameplay, to present the player with important information while not being distracted.

In our game, we will include the following HUD:

- Score.
- Time spent.
- Audio Player.

- Pause
- Hint
- Exit option.

The game will also include the following sound effects:

- Button clicks.
- Earned score beeps.
- Wrong word beeps.
- Winning game (Ta Da) sound.

After establishing the main requirements of our system, we started designing the interfaces to implement the features of the game. The design of the interfaces is simple and follows the W3C guidelines. To achieve our goal, we considered several points such as using icons rather than text. We also used consistent interface colors. The interface design was built after several iterations of the design and consulting five young children aged 10 years old and above as representative of the main stakeholders. After these stakeholders agreed upon the final design, we moved forward with the implementation.

7 System Implementation

We adopted the following tools for implementing the Afaneen game: Android Studio development environment (IDE) for android application development, Java programming language, and SQLite database.

This section will discuss the implementation phases of our game. These phases include the main user interface, one level of interface, spelling rule, previous mistakes, and calculated statistics of the player.

7.1 Main User Interface

This main user interface scene is simple, with consistent color, and contains a Canvas object that contains and controls most important UI elements. It holds the main menu options, which are statistics, levels, contact us, previous mistakes, and the main button to start the game. A screenshot of this scene is presented in Figure 4.

Figure 4 displays the main interface of the Afaneen game. When a player starts the game for the first time, he presses the start button, as shown in Step #5. However, if the player is a returning player, he will be able to check on his level, as shown in Step #1, the statistics of his games (how many points he has collected, the number of mistakes (Step #2)), and the previous mistakes to check on his incorrect entries and determine the spelling accuracy (Step #3). He can contact us through Step #4 or read the game description and the developers in Step #6.

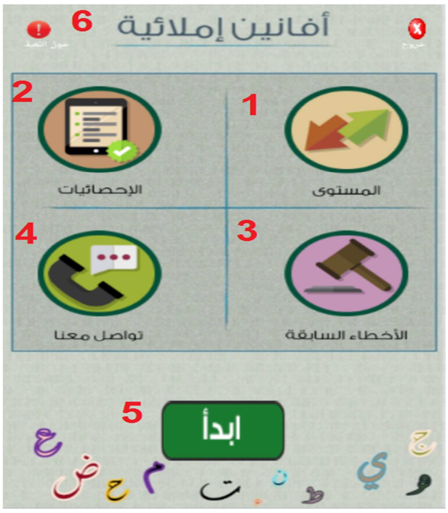


Figure 4: Main Interface of the Afaneen Game

7.2 Game Level Interface

The Afaneen game was designed for the Arabic language. Figure 5 shows one level of the interface along with numbers alongside each function for illustration purposes. These numbers are explained as follows:

1. Represents the pause button where the user can pause the game and complete it at another time. It saves his session and restores it when he plays the game again.
2. Represents the text button to write the chosen Arabic letter in a cursive manner and connects with the other letters to display the written word for the user.
3. Denotes the quit button that a player can press to quit and exit the game.
4. Represents the timer that allows the player to enter the letters of the pronounced words. It is displayed as clock to show the player the time remaining before time-out.
5. Indicates the chosen letter of the pronounced word, and also for adding extra letters that are fixed for each spelling rule to confuse the player and make it more challenging (usually four extra letters close to the correct letters).
6. Represents the help button. When a player presses it, a pop-up window appears that shows the definitions of the associated spelling rule (to remind the player about the rule and its definition to select the appropriate letters).
7. Selecting this icon repeats the pronounced word if the user desires to hear it again to select the correct letters.
8. This button removes one letter in this stage to help the player choose the

correct letters (he has already collected points from entering accurate letters in the previous levels).

9. At the bottom, pressing this icon clears the last letter,
10. Pressing this icon submits the answer. Finally, pressing #11 at the right side displays a pop-up message that indicates if the selected word is acceptable or erroneous.

7.3 Spelling rules, Previous mistakes, and Statistics interfaces

Figure 6 shows the interfaces for the spelling rules, previous mistakes, and calculated statistics of the player. Each screen is numbered for clarification purposes. The #6 icon shown in Figure 6 (left) is the help button. Once the player presses this button, a message pops up on the screen, such as that shown in Figure 6 (left), which demonstrates that #1 is the "close" icon. When pressed, the player is brought back to the game page. The #2 button presents the definition of the spelling rule for the current level to guide the player in remembering the rule and selecting the appropriate letters for the spoken word. Next, the middle panel in Figure 6 shows the page displaying the previous mistakes, which consists of the following:

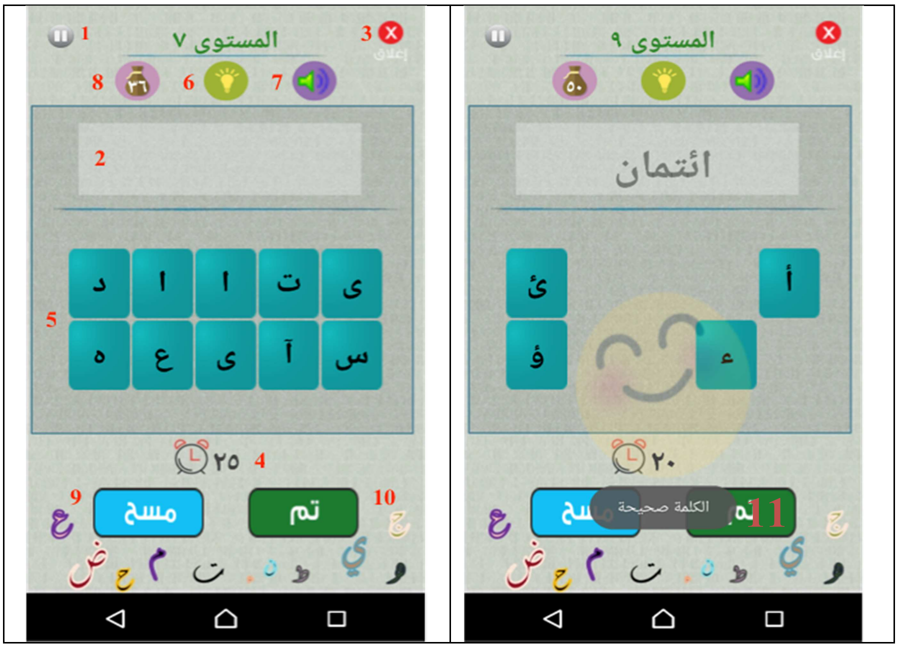


Figure 5: Afaneen spelling page (left) at start and (right) after selecting the correct letters of the pronounced word

1. Represents the home button, which brings the player back to the home page;
2. Indicates the mistaken word written by the player showing a "red x" image;

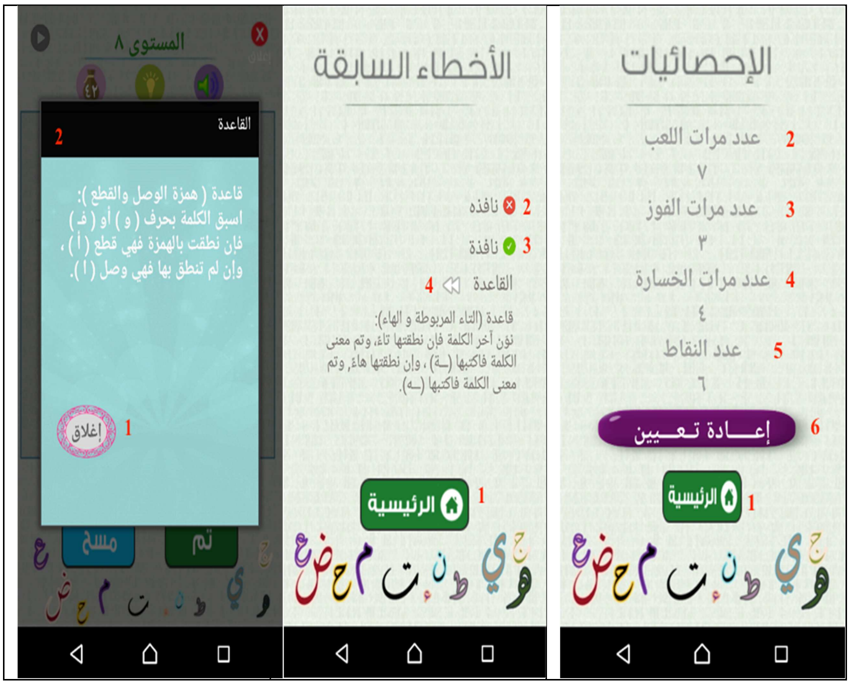
3. Shows the accurately written word;
4. Displays the definition of the spelling rule to emphasize and teach the player the explanation for his mistake;

We expect that the player will remember the mistake and eventually overcomes this in his future writing. Finally, the right panel in Figure 6 consists of the following.

1. Donates the home button and
2. Displays the number of times the user plays the game and counts even the wrong answers.
3. Displays the number of times a player wins (typing the correct word)
4. Shows the number of times he loses (typing incorrect word). The total number of wins and losses are equal to the total games played.
5. Indicates the total collected coins (when writing accurate words in the first attempt within the specified time allowed in the different levels).
6. Represents list of the calculation of the statistics page so that the user can play from scratch again.

Afaneen repeats the spelling rule definitions in more than one page (last mistakes and definition) because it is designed to educate the player about the common Arabic spelling mistakes and intends to improve the player's spelling proficiency.

To our knowledge, Afaneen is one of the first mobile games that address Arabic spelling rules. Thus, evaluation is necessary, which is presented in the next section.


المستوى ٨
٤٢
القاعدة
2
إغلاق
1
مسح
تم
الأخطاء السابقة
2 نافذه
3 نافذة
4 القاعدة
الرئيسية
1
الإحصائيات
2 عدد مرات اللعب
٧
3 عدد مرات الفوز
٣
4 عدد مرات الخسارة
٤
5 عدد النقاط
٦
6 إعـــادة تـعـــيين
الرئيسية
1

قاعدة (همزة الوصل والقطع):
اسبق الكلمة بحرف (و) أو (فـ)
فإن نطقت بالهمزة فهي قطع (أ) ،
وإن لم تنطق بها فهي وصل (ا).

قاعدة (التاء المربوطة و الهاء):
نؤن آخر الكلمة فإن نطقتها تاءً، وتم معنى
الكلمة فاكتبها (ــة) ، وإن نطقتها هاءً, وتم
معنى الكلمة فاكتبها (ــه).

Figure 6: (Left) presenting the spelling rules. (Middle) Presenting the previous mistakes. (Right) Presenting the game statistics

8 Afaneen Game Evaluation

In this section, details regarding the testing process are presented. Our objective was to ensure that the application meets all the system and user requirements. The mobile device used for experimentation is a Samsung Galaxy Note 5 with 1.5 GHz octa-core and 4GB RAM running Android 5.1.1. Three evaluation approaches were used: holistic test case scenario, think-aloud sessions, and interview sessions. These approaches are discussed in detail in the next sections.

8.1 Holistic testing

We developed a holistic test case scenario to evaluate the functionalities of the Afaneen game. We requested a girl player to open and start playing the game to determine both the system functionality and user acceptance. First, we explained to the player the game objective and provided some explanations. We told her that she would hear a word and that she needs to choose the correct letters displayed on the screen. If the chosen word is correct, a clapping sound will be played, and the game will continue with a new word. Our game does not allow the participant to move to a new word unless she has correctly written the previous word. Table 2 lists the test case scenario from starting the game, checking her mistakes, displaying the statistics, resetting the last mistake counter, and exiting the game. In this manner, the game design was aimed (not allowing the player to move next) at emphasizing the educational purpose of training the player in correct spelling. This would enable her to write the word correctly in her future writing tasks. In addition, we informed all the players that the game has nine levels, and each level consists of three words. We provided the spelling rule for each level as a hint for the players to review and choose the correct letter for the pronounced words.

#	Tasks
1	Press start
2	Press Play
3	Play first level and pass to go the second level
4	Press spelling rule
5	Go back to play
6	Play second and third levels
7	Press statistics
8	Press mistakes
9	Reset mistake counter
10	Quit

Table 2: Afaneen test case scenario

8.1.1 Test settings

To assess the performance of our proposed system, we evaluated the system based on the inspection of 14 young people in the age range of 12 to 18 years. Half of them were females and the other half were males, and the participants were middle- and high-school students. We used the system usability scale (SUS) questionnaire because it has been well used to test several services such as mobile and Web applications. The SUS questionnaire consists of 10 questions with five Likert choices ranging from strongly agree to strongly disagree [Affairs, 13]. Because our game is intended for young Arabic speaking people, we have adapted and translated the questionnaire into Arabic and distributed them among the participants. We then asked the players to fill out the SUS questionnaire.

We also asked the participants if they enjoyed the game and whether or not they have played a similar one before. Most of our participants were excited in playing Afaneen, and they felt that our choice of the spelling rules as well the words were suitable. They told us that the idea of the game is unique and novel, and that it helps improve their spelling skills. They liked the changes in the levels and the challenge involved in moving from a lower level to a higher one.

8.1.2 Discussion and Findings

After analyzing the SUS questionnaire responses, we found a positive attitude toward using the system. The participants enjoyed the easy, yet exciting, game. The results show that almost all of the participants wanted to play the game again and be able to provide the correct spelling of all the given words. Interestingly, the young people demonstrated an advanced understanding in playing the game. Thus, all of them stated that the system was not complicated. Moreover, 88% of the participants indicated that the system is easy to use. However, one participant suggested increasing the font size. In addition, a similar 88% of the participants stated that there is no need for a technical-support person help to play the game. They smoothly played it without any assistance. Furthermore, 71% of them agreed that the system is well integrated and consistent. Remarkably, all of them exuded high confidence while playing the game and wished that the game had more levels. Hence, based on [Sauro, 2011], since this score is higher than 70%, these findings indicate a high perceived usability.

8.2 Thinking aloud

To further test our game, we employed the thinking-aloud technique to test the usability of our game. This method is considered a valid means of testing a given application where participants are given a set of pre-instructions and informed that their responses will be recorded either by video or audio. This is a very useful method to learn more about the game and how the players think while playing, as indicated in [Foddy, 1994], to get conversational flexibility from participants.

We applied this test for the same five players whom we sought help from while designing the Afaneen color, as presented in Section 5.2. We told them to speak aloud as if they are having fun with the game and to tell us what they think. In particular, we instructed the participants to focus on the game layouts, spelling rules, letters, and coherence of the system. The participants were helpful in their feedback and suggested to us many useful improvements. Most of them agreed on the smoothness of the system and the straightforwardness of the features while playing.

8.2.1 Discussion and Findings

While using the app, most participants liked the choice of the most misspelled words and informed us that they always made mistakes while typing. For example, some of them did not differentiate between ta-marbodah and ha-maftooh (ه ، ة). As expected, more than half of them made mistakes while typing the last rule for hamza (ء) and did not know its correct location. They stated that the game helped them check their spelling knowledge, and they tried to apply this knowledge in the game. In this manner, they apply the "learning-by-doing" technique instead of memorizing.

8.3 Interview

Part of our game is aimed at education enhancement, and specifically its pedagogical aspect. Pedagogy can be defined as "instructional method of teaching," and this definition suits this game as a means of enhancing the writing skills of young people. We used structured interview questions that were prepared beforehand, where we asked the interviewers to play the game and answer our questions to gather more information about Afaneen. Our questions were aimed at eliciting feedback about educational learnability and the limitations of the system as focused themes, as stated in [Silverman, 2006].

We consulted two Arabic specialists about this app. Both language specialists stated that the game achieves its objective in enhancing the spelling skills as intended. They emphasized the idea of linking most common misspelled words with spelling rules via a hands-on learning approach. Moreover, they indicated the game would enhance the typing skills of the students where the player cannot move to the next level unless he/she has chosen the correct letters for the pronounced word. One of them suggested adding more words to allow the player to learn the rules more thoroughly. Additionally, they stated that the chosen spelling rules are a perfect choice for spelling knowledge as these rules consider the fundamental spelling rules of Arabic language writing, and reflect the most common mistakes made by people of all ages, particularly the young generations. An interesting statement by one of the specialists implied that with the advancement in technology, youths tend to use spell-check mechanisms, which might not always provide the correct spelling. Furthermore, they stated that learning by application would promote faster knowledge acquisition and make spelling rules difficult to forget. Playing a game such as Afaneen will make teaching and learning spelling more attractive and enjoyable in comparison with reading books or depending on traditional methods of teaching spelling such as memorizing lists of words. A recommendation for this kind of app development was a good start in incorporating these types of entertaining activities while teaching spelling to young people. They wished to see more of these projects in the future and the addition of more spelling rules and words.

We also conducted an interview with the software developer with regard to his current work with the Afaneen game. He provided some insights about the limitations of the game. He indicated that the design of the interface is simple. However, it did not conform to the Android standard that the menu should be at the left and cannot be displayed as drop-down menu. He also recommended that the correct word be displayed to the player after making three unsuccessful attempts, and to request the player to write it in a text box to help him/her remember the correct spelling and not lose interest in the game. He also proposed to display the rule definition for the players. In addition, as stated from the abovementioned language specialists, he suggested increasing the number of words in each level (more than three words). He very much liked the idea of the game, especially the ordering of the levels of difficulty of the spelling levels starting from easy to the more difficult level with Hamza (ء), which is mostly inaccurately written. He also recommended adding sentences, instead of words, and varying the type of questions given to the player as a second stage of the Afaneen game.

8.3.1 Discussion and Findings

The abundant feedback on the idea and the design of the Afaneen game have provided us with much optimism for the utility and potential of the game, The experts agreed on the educational learnability of the game toward enhancing the spelling skills. They also approved the choices of most common spelling rules that people, especially young people, make mistakes in. Hence, from the point of view of the language experts, the app is valuable for the Arabic language. It incorporates technology within a teaching framework, and no other such system is currently available for students in the Arabic language. They suggested adapting it as part of the curriculums of the elementary schools where students can learn and practice at any time and any place. In addition, they recommended designing the app in a specific manner that organized the spelling rules as written in the language textbooks. The software developer pointed out the idea of pronouncing the spelling rules for each level, when it starts, to help students recall the spelling rules as they attempt to type the correct letters.

In terms of limitations, the experts stated the need to increase the number of words in each level to be a minimum of five words per level, and also show the correct words after three unsuccessful attempts to keep the player interested, which will be addressed in future work. Overall, these recommendations are valuable feedback, and provide many pointers for future work to explore.

9 Conclusion and Future Studies

This paper presented the design and development of the Afaneen game prototype, an Arabic spelling game that focuses on the nine types of common Arabic spelling mistakes. The target users of Afaneen are young children aged 10 years and older, because the game emphasizes the rules for commonly misspelled words. It can also help adults who like to review the spelling rules. The game can be played on the user’s own device anytime and anywhere without the need for an Internet connection.

The game was designed using the Android platform, and runs locally on the player’s device to allow flexibility in accessing the content of the game. Furthermore, the game was evaluated using multiple approaches—a case study, thinking aloud, and interviews. The results of the evaluation were positive, especially regarding the stages in the game relative to the difficulties of the Arabic spelling rules.

A key characteristic of Afaneen is that its target language is Arabic, which is a widely spoken language in the world, although it has been underestimated by its native speakers and has begun to degrade with time. In addition, it is one of the few games based on technology that addresses in-depth Arabic spelling instructions. Such an application is necessary to meet the demand of the young Arabic generation. Nevertheless, the game has its limitations. One of the limitations is that it fails to address all Arabic spelling rules. It is intended for children who know how to read and write and not those who are still learning basic literacy skills, such as first-year elementary students.

With regard to our future work, we intend to develop the game for the iOS platform, as currently it is only available for the Android platform to make it more accessible to young people. Further, we intend to include more spelling rules and increase the number of stages. We are also considering ways to make it more interesting, such as by adding text with some misspelled words and asking the players to correct them. We plan to introduce the game to language teachers to enable them to integrate the game in their courses and provide us with teacher and student feedback on the game. It would be interesting to use the game as an additional material for spelling lessons in school, and then assess its impact on the improvement of students' writing.

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