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**A Mobile Application for Improving Student Reading Fluency,
Comprehension, Engagement and Satisfaction Using Universal Design for
Learning and Digital Storytelling**

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Thesis Submitted for the Degree of Doctor of Philosophy

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Declaration

I hereby declare that this thesis has not been and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature: Sara Bandar D Alharbi

University of Sussex**Thesis submitted by Sara Bandar D Alharbi****Abstract**

The purpose of this research is to examine the effect of a novel mobile education application that uses Universal Design for Learning (UDL) and digital storytelling on the reading fluency, comprehension, engagement and satisfaction of children learning to read Arabic. For the purpose of this research, an interactive mobile learning application was developed based on the idea of targeting learners' individual needs, where students progress from reading single words to sentences and creating their own stories and sharing them on a bespoke website. The participants for this study were second-year primary school children, their parents and their Arabic language teachers from different primary schools in Saudi Arabia. Due to the closure of the schools in Saudi Arabia as a result of the Covid-19 pandemic, this study was conducted online. This study employed both qualitative and quantitative approaches to measure the effectiveness of the interactive tool and to obtain knowledge about the pupils' technological backgrounds. The qualitative approach involved online semi-structured interviews for the teachers and online observations of children interacting with the application. The quantitative approach is based on online questionnaires for both the children and their parents to obtain opinions about the system, while the parent survey also examined the children's prior knowledge of using technology and the home literacy environment. Additionally, the quantitative phase involved pre- and post-tests to assess reading fluency and comprehension of the experimental and control groups before and after the experimental group engaged with the application. The qualitative results showed that the application elicited a high level of engagement and satisfaction; and the quantitative results strongly indicated that children who used the system had increased reading fluency and comprehension compared to the control group. The results of this research strongly indicate that a mobile system based on UDL and digital storytelling can have a significant positive effect on fluency, comprehension, engagement and satisfaction when learning to read Arabic.

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Publications

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Chapter 1: Introduction

1.1 Introduction

The modern world has seen a rapid rise in everyday use of digital technology, which has become more affordable for people worldwide and radically affected many aspects of their lives (Ally and Prieto-Blázquez, 2014). This technology has developed further to include many interactive features and to be available in mobile devices such as smartphones and tablets which mean that users can access and transfer information anytime and, increasingly, from anywhere (France, 2021). Educational settings have also witnessed the introduction of mobile technology in the 21st century, which has meant some profound changes in teaching and learning methods and created a new educational paradigm called mobile learning (M-Learning) (Chee. et al, 2017).

Mobile learning has also been applied to storytelling, which has had a long tradition of being used to impart information both informally and as part of the formal curricula in schools (Rahiem, 2021). Traditional storytelling has now been transformed into digital storytelling and this is now part of a new teaching and learning strategy which uses technology to improve children's engagement and their learning experience (Taylor et al., 2018). This strategy can also be used in conjunction with gamification (Molanar, 2018) or augmented or virtual reality (De Lima et al., 2014; Gelsomini et al., 2016)

Digital storytelling (DST) as a teaching and learning method has a number of advantages, not least that it has been shown to motivate children to learn and improves the rapport between pupils and teachers (Nazuk et al., 2015). Other scholars have noted that DST can meet children's need for self-expression (Sarica and Usluel, 2016), and is a good strategy for student-centred learning where children need to be highly engaged (Abdel-Hack, and Helwa, 2014). DST also facilitates the creation of a learning environment that supports problem-solving in both peer-to-peer and collaborative communication (Rao and Meo, 2016).

In contrast to traditional methods, where it can be difficult for teachers to design lessons that meet the diverse needs of all their pupils, digital storytelling is a strategy that can better accommodate a wide range of diversity in the learning environment (Capp, 2017). The traditional teacher-centred strategy standardises the learning process and so is less able to address the differences between learners' individual abilities or engage pupils either with or without disabilities (Rogers-Shaw et al., 2018; Capp, 2017). The standardised materials, text-based discussions and assessments used in the traditional approach often do not suit the needs

of every pupil, particularly those disadvantaged by language barriers or disabilities (Rogers-Shaw et al., 2018).

One way of making the learning environment more inclusive is to introduce learning materials and assessments that are accessible to every learner. Universal Design for Learning (UDL) is a promising way to make learning materials accessible for learners with a diverse range of abilities and meet the needs of each pupil (Kumar and Wideman, 2014; Rogers-Shaw et al., 2018). This strategy benefits both pupils and teachers as it shifts the focus away from the disabled pupil to the disabled curriculum and facilitates student-centred approaches (Rogers-Shaw et al., 2018).

This study aims at demonstrating that an educational mobile learning application that combines the three methods above (mobile learning, digital storytelling and UDL), will improve children's fluency, comprehension, engagement and satisfaction when learning to read in Arabic.

1.2 Problem Statement

The Saudi government has been investing heavily in making improvements to the educational system (Moe, 2021). Nevertheless, there are still many challenges facing Saudi education, not least that many institutions still adhere to traditional methods of education and not enough attention is paid to students' motivations and needs. This traditional approach is based on face-to-face education inside the classroom and uses traditional teacher-centred methods for providing learning materials via in-class technology, such as projectors and computers. Due to the number of teachers in a class (one) and the number of children (approximately 35), interaction is limited and so supporting interaction via novel learning tools can be of benefit to help the students to learn independently by themselves which in turn leads to a shift in the educational practice from a teacher-centred approach to a student-centred one. For this to happen, teachers need to acquire the teaching and learning methods that facilitate a more student-centred approach and educational establishments need to be open to implementing innovative strategies. This research addresses these issues by proposing a system which is based around mobile learning, i.e., Universal Design for Learning and Digital Storytelling.

According to the Saudi Vision 2030, there is a need to develop the education system, especially early childhood education, through refining the national curriculum and focusing on advanced technologies (Vision, 2016). This research will apply mobile learning for enhancing learning and teaching methods. However, although several applications have been developed by

researchers interested in the general functionality of mobile devices they are not optimized for learning (as discussed in Chapter 2). Moreover, although there are a few applications designed for Arabic (Ghafar and Noor, 2017; Hashim et al, 2017; binti Zamri, and Shariman, 2020), there is a lack of mobile learning applications that are in-line with the formal curriculum for Saudi primary school students, and this presents a gap in support for student learning which is addressed by this research.

In terms of the universal design for learning (UDL) framework, which aims to design and deliver classroom instruction by addressing learners' needs (CAST, 2018), many studies have been published on the usefulness of UDL as an instructional design framework and course design (Almumen, 2020; Narkon and Wells, 2013; Alquraini and Rao, 2020), and most current studies include different levels of descriptive information. However, there is a limited number of empirical studies (as discussed in Chapter 2).

There is also a lack of studies that use digital storytelling in the Arab context especially in Saudi Arabian schools; more precisely, that have applied digital storytelling in-line with the formal school curriculum, leaving significant potential for a system which combines digital storytelling with UDL and mobile delivery specifically for learning Arabic in Saudi Arabian primary schools.

1.3 Research Aim

The aim of this study is to improve student's fluency, comprehension, engagement and satisfaction by designing an educational mobile learning application for reading in Arabic in line with the language curriculum. This mobile learning application combines both digital storytelling and UDL.

1.4 Research Approach and Objectives

This thesis develops and tests a novel mobile learning application by integrating digital storytelling and UDL and subsequently assesses it. The system is specifically designed to meet individual pupils' needs and preferences while they learn how to read in Arabic.

The main objective of this research is to improve students' reading fluency, comprehension, engagement and satisfaction by the use of the novel developed mobile learning application. The objectives can be summarized as follows:

- Examine how the students are being taught in the classroom.

- Examine the students' prior experience of using technology and their home environment in terms of literacy.
- Develop an educational mobile learning application that combines digital storytelling and universal design for learning.
- Pilot test the system's functionalities to assess usability and methodology.
- Evaluate the developed system in a full study to measure its effectiveness on student reading fluency, comprehension, engagement and satisfaction.

1.5 Research Questions

The main question in this research is:

“Can the proposed novel educational mobile learning application enhance learners’ reading fluency, comprehension, engagement and satisfaction while reading in Arabic, and make learning more effective than traditional learning styles?”

The question will be divided into a series of sub-questions:

- 1- Is student fluency improved by the system?
- 2- Is student comprehension improved?
- 3- Is engagement increased?
- 4- Do students express satisfaction when using the developed system?
- 5- Does the use of M-learning, Digital storytelling and UDL effectively support children with a range of learning preferences?

To answer these research questions, a mobile learning application is developed and assessed in this study using the following assessment techniques:

- Tests: pre- and post-tests measure students' fluency and comprehension before and after using the proposed system.
- Observation: Researcher observation and unstructured notes are used to observe the students and their interactions while using the proposed system.
- Questionnaires: A post-experiment questionnaire is used to measure students' satisfaction with the proposed system and its various characteristics, and to get their feedback about using the system and its functionalities. A parents' questionnaire is used to obtain general background information about the students, their use of technology at home and home literacy environments.

- **Teacher Interviews:** These are used to explore how the students are being taught in the classroom, and to get the teachers' feedback about the proposed system and to check if it is in line with the curriculum and suitable for children of their students' age.

1.6 Hypotheses

There are four key hypotheses to be tested, using the students' pre- and post-test scores for measuring their fluency and comprehension and the post- experiment survey, and which are:

H1: There will be no significant differences between the experimental and control groups' pre-test scores in reading fluency and comprehension.

H2: The post-test will show a measurable increase in reading fluency and comprehension of the experimental group.

H3: Comparing the pre- and post-test scores will show measurable positive differences in the experimental group, in comparison to the control group.

H4: The developed system will be experienced as engaging and usable and offering a good level of satisfaction.

1.7 Research Contribution

This study contributes to the knowledge and practice related to mobile learning applications by developing a new mobile learning application that integrates digital storytelling and UDL. The main research contributions of this research are:

1. Development of a novel system which integrates three existing e-learning methods (mobile learning, digital storytelling and UDL) for learning in Arabic language teaching.
2. This research provides a novel e-learning system that increases children's fluency and comprehension, engagement and satisfaction levels.
3. This study contributes to the literature on mobile learning in Arabic by providing an Arabic mobile learning application that is in-line with the formal curriculum of the Saudi primary school.
4. This study contributes to the literature on Universal design for learning (UDL) by providing an empirical study through practical application that applies the principle of UDL.
5. This study contributes to the literature on digital storytelling in the Arab context generally, and Saudi Arabiaspecifically by providing a digital storytelling mobile

application.

6. A methodology for studying developed e-learning applications with second year primary school children from different primary schools in Saudi Arabia. Moreover, an online methodology for studying developed e-learning applications with second year primary school children from different primary school in Saudi Arabia. (Modifications made due to the Covid-19 pandemic).
7. Insight in to the perceptions of different stakeholders in e-learning systems; students, parents/guardians and teachers, regarding their perception of e-learning and using the developed system in educating children in the class in a Saudi Arabian context.

1.8 Thesis Outline

This section demonstrates how the thesis chapters are organized and a short description of each is provided.

Chapter 1: Introduces the key terms of the current research and defines the research problem. It also demonstrates the main objectives, research questions and hypotheses of this research. It describes the potential contributions that the study makes in the field.

Chapter 2: Provides a literature review covering the key terms used in this research; education in Saudi Arabia, mobile learning, digital storytelling, universal design for learning and reading fluency and comprehension. It provides details about the information related to these terms and the importance of each of them, and also identifies the gaps in existing literature.

Chapter 3: Describes the design of a new educational mobile learning system.

Chapter 4: Provides details about the research methodology and data collection employed in the pilot study and discusses the findings of the pilot study.

Chapter 5: Provides details about the research methodology and data collection employed in the main study and discusses the data analysis and findings of the main study.

Chapter 6: Discusses the findings of the main study.

Chapter 7: Outlines the general conclusions of the thesis, its limitations and recommendations for future work.

Chapter 2: Literature Review

This chapter outlines the main components of the research and is divided into five main sections, as follows: education in Saudi Arabia; overview of mobile learning; digital storytelling; Universal Design for Learning (UDL), and reading fluency and comprehension.

2.1 Education in Saudi Arabia

Education was and remains an important issue in the Kingdom of Saudi Arabia as it is the cornerstone of building society and creates the future workforce. Islam values education; and in fact, the root of the Saudi education system springs from the religious belief that all people require education (Saleh, 1986). Therefore, the Saudi Ministry of Education has made improving the quality of education a priority.

The Kingdom of Saudi Arabia has a long-term plan called Vision 2030, which was proposed by Prince Mohammed Bin Salman. One of the cornerstones of this vision is educational development. In his vision, the prince stated that “we will prepare a modern curriculum focused on rigorous standards in literacy, numeracy, skills and character development.” (Vision 2030, 2016, p. 39).

The Minister of Saudi Education stated that the current education system is a result of the past and not suitable for the future (Pennington, 2017). Thus, the Saudi Education system faces many challenges especially in the current times. Although the Saudi government is earmarking a significant amount of money to improve education, there is a deficit in the support of students’ needs and motivation. Therefore, schools need to adopt innovative solutions to overcome the problem of being considered as undesirable places for students. Also, teachers need new philosophies as well as new teaching and learning methods to keep up with development and innovation.

2.1.1 The Covid-19 Pandemic and its Effect on the Saudi Educational System:

The first case of the coronavirus, called Covid-19 was officially reported from Wuhan in China but then the coronavirus crossed the border of China to 114 countries with 118,000 reported cases and 4,291 deaths during the first two weeks of March 2020 (World Health Organization, 2020). The World Health Organization (WHO) declared coronavirus as a pandemic on 11th March, 2020 (World Health Organization, 2020).

The COVID-19 pandemic forced a rapid lockdown situation which caused a full transition to entirely online teaching for schools in Saudi Arabia. On the 15th August, 2020, the Ministry of

Education in Saudi Arabia announced that distance education was to be implemented for all stages of general education for the first seven weeks, starting on 30/08/2020 which was then extended to the whole term. This involved the teachers working remotely with their students through virtual classrooms as well as attending their schools once a week as arranged by the schools' administration.

The Madrasati platform (My School), is the online platform, that the Saudi Ministry of Education uses for virtual classes during distance learning, and it serves over six million male and female students from public, private, foreign and international schools. Additional to the Madrasati platform, 23 local satellite channels broadcast at regular intervals during the day to cover all academic levels to ensure that knowledge reaches all students, especially those who do not have access to the internet. The school day 'remotely' starts at 9:00 a.m. and finishes at 2:00 p.m. for secondary and high schools while it runs from 3:00 p.m. until 8:00 p.m. for primary schools.

2.2 Mobile Learning

The rapid development in technological advances has increased significantly in the last few years, and smartphone devices have become more portable, connective, ubiquitous and affordable (Melhuish and Falloon, 2010) and changed the way we live (Ally and Prieto-Blázquez, 2014).

Smartphones and tablets have different interactive built-in features such as WIFI, Bluetooth, camera, microphone, touchable screen and more (Dabney et al, 2013). These features have led to an increase in the number of mobile applications (Lu et al, 2014) and shifted the focus from desktop applications to more powerful mobile applications (Dabney et al, 2013; France, 2021) which offer the user the ability to access and transfer information (France,2021) anytime and anywhere (Lu et al, 2014; Al-Emran, 2016).

Therefore, people can learn, entertain, socialize and complete everyday tasks using these devices (Ally and Prieto-Blázquez, 2014). The popularity of smartphones and smartphone applications have increased their usage in the educational settings, especially in higher education (Ally and Prieto-Blázquez, 2014; Kaliisa and Picard, 2017) which, of course, changed learning methods in the 21st century and created a new learning and teaching paradigm called Mobile learning (M-Learning) (Chee. et al, 2017).

Many researchers have different definitions of M-Learning. According to Quinn (2000), M-Learning is defined as the intersection between mobile computing, such as cell phones and

personal digital assistants (PDAs), and e-learning to access resources independently from location or time. Similarly, Barreh and Abas (2015) defined M-learning as the way of learning through mobile devices that have wireless connectivity to allow the learners to enhance their learning experience anywhere and at any time. Alzaza and Yaakub (2011), consider M-Learning as a way of learning that overcomes some of the limitations of E-learning and therefore expands E-learning by using mobile technologies. In contrast, Ally and Prieto-Blázquez (2014, p.4) argued that M-Learning is to do with learners being mobile and not only about the technology, and stated that “The learner is mobile and is at the centre of the learning, and the technology allows the learner to learn in any context.” Based on figures by Supplygem (2021), the Mobile Learning Market has an expected revenue of \$38 billion by early 2021 as more institutions and people realized the importance of M-Learning.

The unique features of mobile devices will encourage educators to adopt M-Learning in their classrooms in order to help learners to have a unique experience during their learning process. M-Learning allows students to learn at anytime and anywhere in their community via their own smartphones, tablets and iPads (Alkhalaf, 2015; Chee, 2017); which makes the learning process flexible, adaptable and enjoyable (Kaliisa, and Picard, 2017) by overcoming the limitations of using desktop applications and traditional learning methods. Although in theory using a laptop could be considered M-Learning (in that it is portable), the term M-Learning generally implies touch screen interaction, which allows both teachers and learners to connect, interact and communicate with each other (Alkhalaf, 2015; Chee, 2017) in ways unlike those in the traditional learning settings. Furthermore, touch screen interaction helps the learners to collaborate to complete their tasks and share information (Ally and Prieto-Blázquez, 2014). Moreover, Mobile learning has shifted the focus to student-centred learning from the traditional teacher-centred methods by allowing the learners to access up-to-date educational resources (Ally and Prieto-Blázquez, 2014) with different learning styles (Alkhalaf, 2015). Many educationalists believed that students have different abilities and needs and by using mobile technology, students will have more agency over their studies.

Many studies have proved the effectiveness of mobile devices as effective, educational tools in primary and secondary classrooms and in higher education. They have been used in medical education (Witt et al., 2016), computing education (Dabney et al 2013), language learning (Ho, 2018; Gabarre et al., 2014; Lu et al., 2014), science education (Zydney and Warner, 2016), physics (Maryam and Susanto, 2019) and mathematics (Borba et al., 2016) among others.

There are many mobile learning applications designed for teaching and learning English (Boyinbode, 2018; Sadiq et al., 2021), Chinese (Lu et al., 2014; Ho, 2018), French (Gabarre et al., 2014), and a few have been produced for the Arabic language, such as for learning Arabic as a foreign language (Ghafar and Noor, 2017; Hashim et al., 2017) and for teaching Arabic numbers to non-native speakers (binti Zamri and Shariman, 2020).

Hashim et al. (2017), aimed at developing Mobile Augmented Reality for teaching Arabic and examined its effectiveness on primary students aged 7 years old. The application was called ‘Arabic’ and was developed based on the formal Arabic curriculum in Malaysia. The application included two modules: learning modules and exercise modules, as shown in Figure 2.1.

The learning module contains the topics that existed in the formal textbook, where the students were able to learn them. The application contains translation from Arabic to Malay to help both the parents and their children while learning and teaching Arabic. It also includes text, pictures, animation, audio and video. The 3D model with audio or video buttons appears when the user points the phone’s camera onto the indicator for a specific word. The exercise module is where the students can revise and ensure that they remember what they have learned. The students are asked to find objects they have studied by following given instructions. The 3D element marked right or wrong appears based on students’ answers.

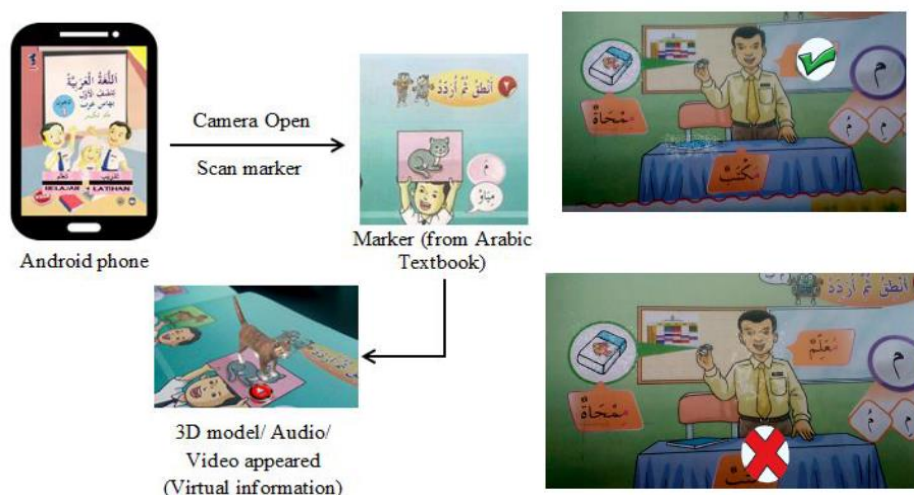


Figure 2.1: Learning module and exercise module (Hashim et al., 2017)

The authors used questionnaires with parents and teachers to assess the system’s effectiveness. The results showed that respondents believed that the application was easy to use, would attract

students and help them to learn. Also, this study integrated the formal curriculum with augmented reality. However, there is no measure to investigate the effectiveness of this application on the students learning Arabic.

The study by binti Zamri and Shariman (2020) aimed at developing a primary level mobile learning application for teaching Arabic numbers to non-native speakers. Although this application has not been implemented, it was devised and built based on Mayer's five multimedia learning principles (Mayer and Moreno, 1998) and contains only the Arabic numbers from 1 to 10 to help children to recognize the numbers and know their pronunciation. The application includes guidance for the children, multimedia, visuals and animations and a voice which plays when the player presses the number on the screen, as in Figure 2.2. All of these features offer interactive content to motivate the children to learn while they finish the game.

The authors believe that this mobile application could enhance the learning experience of children, as they learn Arabic numbers in fun and interactive way. However, the authors of this paper only discussed the design and development phases while the implementation and evaluation phases were not conducted, and this is considered a drawback as they did not test the application on groups of children to investigate the effect of this mobile application on their experiences of learning.



Figure 2.2: Screenshots of mobile learning application for teaching Arabic numbers to non-native speakers (binti Zamri, and Shariman,2020)

A study by Ghafar and Noor (2017) aimed at developing a mobile Game-based Learning (mGBL) application to help students learn Arabic vocabulary by using vocabulary learning strategies, contextual guessing and dictionary use. The participants were secondary school students in Malaysia who were studying Arabic. The user of this mobile application is first asked to write their name or nickname, then an instructional clip appears. The application includes many quiz sets where each set comprises 3 target words. The user can press on each word to obtain additional information about it such as its meaning and type. Moreover, the application provides only 2 options for the guessing strategy for each target word. For each

set, once the user has finished the set they can progress to the following set until they have finished. The application provides rewards and feedback based on students' answers, as shown in Figure 2.3.



Figure 2.3: Screenshots from Game-based Learning (mGBL) application (Ghafar and Noor, 2017)

The study used structured interviews with the students, and showed that the students believed that this was a helpful tool for learning Arabic which could help them to achieve good scores in their assessments and exams. It included different features such as rewards and feedback which allowed users to know their performance and level. Even though this application has good features, it is still limited as it only teaches students 3 target words at a time. The authors did not mention the size of their sample; neither did they measure the effect of the mobile application on students' learning and vocabulary acquisition despite the possibility of obtaining quantitative data from the quizzes.

Sadiq et al (2021) developed a mobile learning application for teaching English as a second language to children based on Child-Computer Interaction (CCI) standards proposed by Kraveva (2017). They used mixed methods to collect quantitative data using a survey and a pronunciation test, whilst qualitative data was collected via semi-structured interviews. The survey was to obtain expert opinions about the design of the system and whether it was in line with the CCI standards. The semi-structured interviews were used to obtain children's perceptions of the developed system. Moreover, the pronunciation test, which consisted of 15 questions, was used to check whether the pronunciation of the participating children was improved after using the system.

The participants were thus both experts and child participants. The former comprised 37 experts on educational technologies and were of mixed gender and aged 25 years and above. The 10 child participants were girl and boys aged between 10 and 12 years old who owned Android devices. The resulting application was developed to fit the Android platform, and was designed to focus on pronunciation, reading, speaking and listening skills. For the listening skills, a story about animals is played by using text to speech, where the story is divided into simple sentences, and the colour of the words changes while the story is being read. For the

speaking skills, a picture of a specific animal in the story will appear when its name is read out by using text to speech. The story can be repeated using navigation buttons. For the reading skills, a picture of the animal appears and the child pronounces the name of this animal and records the pronunciation using the microphone. The application tests the child's pronunciation using a voice recognition system, as shown in Figure 2.4.

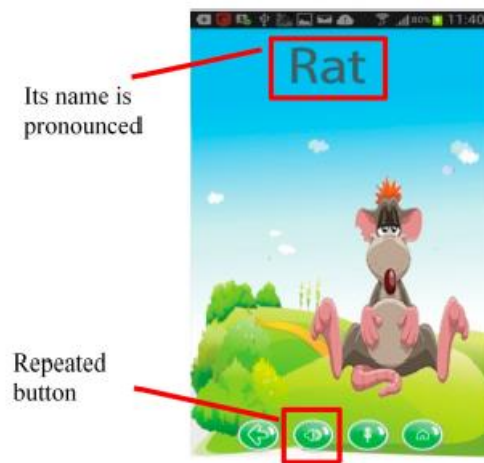


Figure 2.4: Screenshot of mobile learning application for teaching English (Sadiq et al, 2021)

This system was used twice a week (one hour each time) for two weeks. The teachers tested the children's pronunciation of 20 animals before using the system; where they were presented with a picture of each animal along with its written name and asked to pronounce it. The same teachers performed the post-test and presented 15 pictures of the animals to the children after using the system.

This study demonstrated that the developed application was suitable for teaching English as a second language to children, based on both the experts' opinions and the way children appeared to be happy to use it. The pronunciation test results showed an improvement in the students' pronunciation after using the developed system. This study produced an effective tool for learning English vocabulary. The researchers used pre and post-tests to prove the effectiveness of the developed application on children's pronunciation. However, the application could be improved by having words change colour to make children follow more easily while they read. This study did not test students' ability to read and only focused on the pronunciation of specific words i.e. animals' names. Although this study used two participants groups, it had the limitation of a small sample size; used only one experimental group and no control group to compare between them. It also used participants of different ages between 10 and 12 who have different abilities based on their age. Even though the app uses stories about animals and

presents pictures of the animals, children cannot create their own stories. Moreover, the topic may not be entirely suitable for all children over the range of the learning levels tested, therefore, it could be enhanced by adding more topics and objects such as flowers, places, fruits etc.

Based on the previous research on mobile learning and its applications, there is a motivation to apply mobile learning in Saudi Arabian schools in order to enhance learning and teaching methods. However, many of these applications have been developed by developers interested in the general functionality of mobile devices and are not optimized for learning. Additionally, although several applications are designed specifically for teaching and learning Arabic (Ghafar and Noor, 2017; Hashim et al., 2017; binti Zamri and Shariman, 2020), there are still only a few applications and a significant gap in the literature that needs to be addressed.

2.3 Digital Storytelling

Storytelling has been a part of human life for thousands of years and is one of the oldest methods for communicating between people, learning from each other, passing on information and knowledge and the recounting of experience and adventures (MacDonald, 2013; Bratitsis and Ziannas, 2015; Razmi et al., 2014). Storytelling is for everyone not only for children and it was used as means of retaining cultural traditions and as instruction to prepare young people for different aspects of their adult lives (MacDonald, 2013; Rahiem, 2021). It is an activity that people experience from their childhoods, either by listening to people's narratives or creating their own narratives (Garzotto, 2014). Moreover, it is considered as the ancient art of entertaining by telling a story which has a message to convey or to stimulate readers' or listeners' emotions by describing actions and events and situations similar to that which the audience has experienced (Garzotto, 2014).

With rapid technological advances, traditional storytelling, which is based on oral storytelling, or written on paper, has been changed and developed into a digital format known as digital storytelling (Garzotto, 2014). The term 'digital storytelling' was coined in the early 1990s by Joe Lambert who was the co-founder of the Center for Digital Storytelling (CDS) located in Berkeley, California. This training centre helps people to create, build, write and share their own stories (Robin, 2008; Robin, 2016; Abdel-Hack, and Helwa, 2014).

The definitions of digital storytelling (DST) follow much the same themes: Robin (2016) has defined digital storytelling as the art of matching stories about a specific topic or theme to digital media such as pictures, text, audio and video, and using computer software to make

short digital stories that are around two to ten minutes long and then uploaded to the internet to be viewed. Garzotto (2014) states that digital storytelling comprises multimedia stories that could be delivered on many different platforms such as audio from speaking toys and computer games which the children can interact and be engaged with and which help them to increase their creativity, enjoyment and learning. Similarly, Casillo et al. (2016) defined DST as the combination of traditional storytelling with a variety of multimedia elements such as images, audio, animation, music video and interaction to express and narrate experiences or situations in order to make the learners more engaged with the learning materials as well as more active when they learn. The research by Robin (2006), proposes that there are three main types of digital stories: personal stories which are stories about the incidents that have happened in someone's life, historical stories which are stories about events that happened in the past that help people to comprehend their history, and informing stories which are designed to teach people about a specific topic or concept.

Digital storytelling has become a global phenomenon which is used in varied areas; for example: in museums; for cultural heritage and tourism (Casillo et al, 2016, Ioannidis et al., 2013) and health care (Hardy and Sumner, 2018). In addition, DST has become a powerful tool, especially at different levels in educational settings from early childhood to higher education, as it supports teaching and learning (Rahiem, 2021; Robin, 2016). As a result, learners become designers, thinkers, publishers, writers and more (Rubegni and Landoni, 2014)). It is an important teaching strategy and a powerful approach to simplify complex matters by using technological advances in the classroom to enhance students' learning experience and engagement (Taylor et al, 2018). Educators can use digital storytelling in their classroom alone, or they can combine it with augmented reality (De Lima et al, 2014), virtual reality (Gelsomini et al, 2016) or Gamification (Molanar,2018).

According to Nazuk et al (2015), DST is considered as an optimum teaching strategy as it serves many goals at once during the class. It motivates students to learn, controls them and strengthens the relation between them and the teachers as well as enriching their learning experience which increases their performance. Sarıca and Usluel (2016) mentioned that DST aimed at meeting individual needs such as self-expression and communication, while they are being taught to improve their skills. Abdel-Hack, and Helwa (2014) considered DST as an innovative approach that has significant impact in motivating and engaging students and enhancing their learning outcomes in student-centred learning. It also helps the teachers to

build a learning environment that supports problem-solving in both peer-to-peer and collaborative communication.

Many researchers have conducted research with digital storytelling used in different courses in higher education such as hybrid courses and learning English as a second language for pre-service teachers (Shelton et al, 2016), English as a foreign language (EFL) for undergraduate students (Ramzi, 2014), writing and critical thinking for EFL (Abdel-Hack and Helwa, 2014), accounting (Taylor et al., 2018); in schools, for modules such as microbiology (Molnar, 2018), reading and writing skills in Spanish (Cordero et al., 2015), science courses (Hung et al., 2012); chemistry (Nam 2017) and music (Chao-Fernandez et al., 2017).

Also, many researches have examined the usefulness of using DST in learning languages such as English (Hwang et al 2016; Abdel-Hack, and Helwa, 2014), Spanish (Perez, 2015; Cordero et al., 2015), Chinese (Li and Hew, 2017) and Arabic (Baharudin et al., 2010). Additionally, several studies have explored how storytelling can improve children's learning in special education. For example, with children who have hearing difficulties (Chao-Fernandez et al., 2017), autism spectrum disorder (Siller et al., 2014; Hilvert et al., 2016) intellectual developmental disability (Gelsomini et al., 2016) and dyslexia (Rahmani, 2011).

Many studies have claimed DST's positive effect on learners' social interaction, learning motivation, learning achievement and academic skills (e.g., Alismail, 2015; Hwang et al., 2016; Hung et al., 2012). It helps students to control their anxiety and can enhance the relationship between students and their teachers (Nazuk et al., 2015). It increased students' writing skills and visual memory (Sarica and Usluel, 2016) and speaking skills (Hwang et al., 2016). It enhances writing narratives for students who learn English as a second language and improves their critical thinking skills (Abdel-Hack and Helwa, 2014); and increases the ability of students to memorize and understand materials because of its multimodal approach (Taylor et al, 2018). It enables co-creativity between students while they work collaboratively, and improves students' self-expression, organizational and presentational skills and enhances their creativity (Ramzi, 2014; Abdel-Hack and Helwa, 2014; Alismail, 2015). According to Robin (2008), DST enhances students' communication skills because they organize and create new ideas, search for new information, express their ideas and ask questions while they build the narratives. By sharing each other's work, they enhance their ability to criticize their own or peers' work, which in turn will assist their emotional intelligence, empathy and social

awareness (Bratitsis and Ziannas, 2015). DST also makes the learning process more personal, and attractive and improves students' language skills (Razmi et al., 2014).

Baharudin et al. (2010) completed a study which aimed at using interactive storytelling for teaching Arabic language to 1st year primary school children in Malaysia. The study aimed to apply storytelling to teach students to differentiate between words based on gender. The system, which was installed on CD, has three components: Firstly, the tutorial, where students select the type of lesson they wish to learn; Feminine (1) or Masculine (2). If the user selects 'feminine', a new page will appear where the student will learn about Arabic grammar and some Arabic words with their translation into Malaysian which are related to the feminine. Secondly, storytelling, which consists of two parts, 'Adam playground' and 'Hawa playground', so the children will see how the words from the first part can be used; and finally, an exercise to test children's understanding of feminine and masculine words. as shown in Figure 2.5.

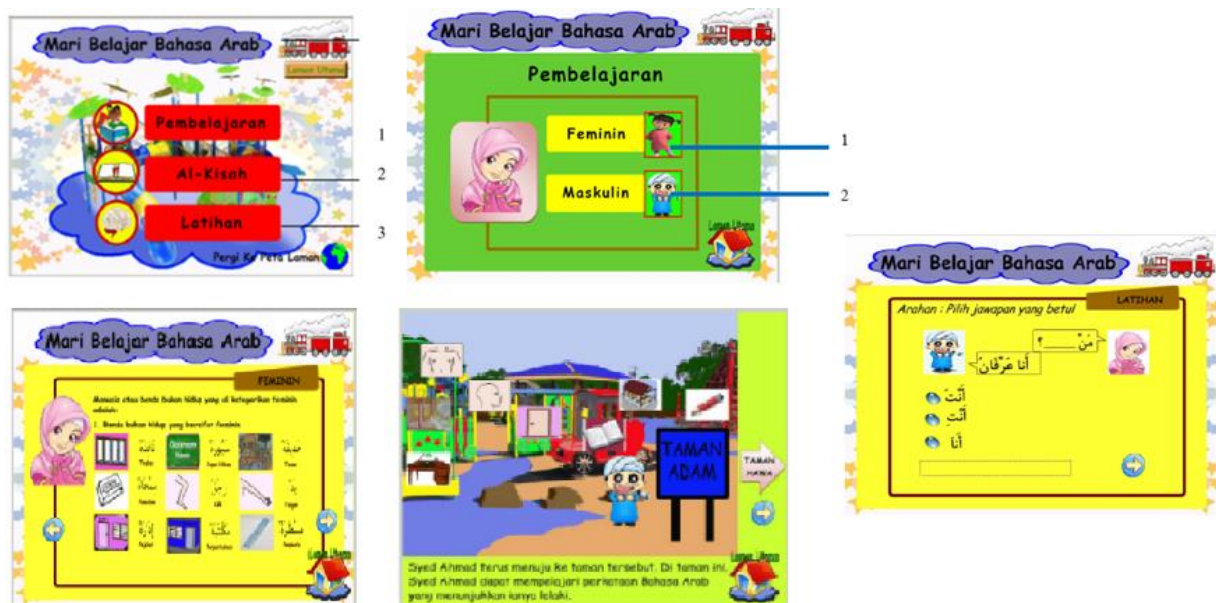
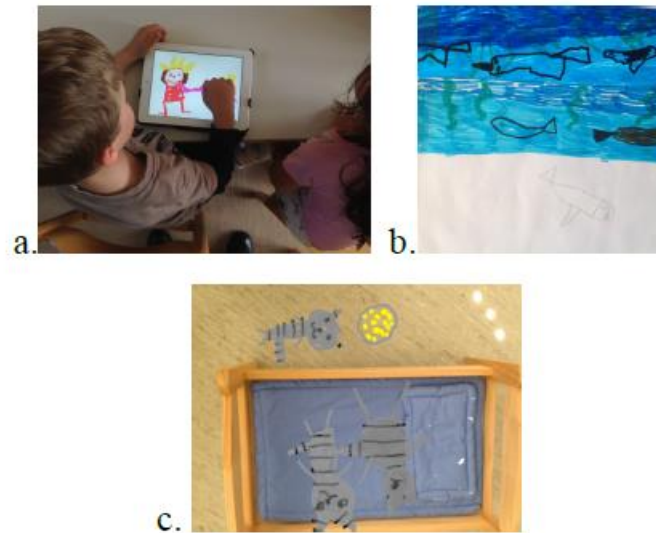


Figure 2.5: Screenshots of STAr: Story telling for teaching Arabic (Baharudin et al., 2010)

The results of this study demonstrated that even though the students spent less than 30 minutes interacting with the system, most of them achieved marks of above 80% and were able to recall the words better. However, the authors did not mention how the result was assessed nor discuss using the pre-test and post-test, and did not compare this tool against other existing teaching materials. This study applied the basic concept of the storytelling as the application contains

pictures and text. It offers a small amount of flexibility for children to choose where to start to learn as some of them might start with the tutorial while others may start with exercise or story. However, the published research lacks some important details such as the size of the sample, the methodology used and how they analyzed the data. The system does not allow children to build their own stories or offer a read-aloud feature to allow the children to hear the words, therefore students may have difficulties in pronouncing the words.

Rubegni and Landoni (2018), produced a study aimed at designing an authoring tool for creating digital storytelling for pre-literate children. The study was conducted with infant school children aged 5-6 who were selected by their teachers and based on their proficiency and skills. This research uses the theoretical foundation of socio-constructivism as well as children's development as a theoretical framework. The researchers selected the iPad and three separate applications which are easy to use by the pupils. Their pilot study followed the qualitative approach which included interviews with teachers, observation of activities and focus groups for both educators and pupils. The pilot study had 3 phases, as seen in Figure 2.6. In the first phase consisted of the activity analysis, and plot creation. In this phase, the teacher presented the story structure and its main elements to the children and asked them to draw three drawings using crayons and paper. Then the children were divided into two groups to select the drawings that could be used for the story creation with the help of the teacher. The second phase aimed at training the children in using the device for creating digital storytelling. In this phase, the iPads were given to the children and the researcher explained how to use it for making drawings, creating sounds and taking photos by using the simple applications selected by the researcher. The children worked in pairs and created many drawings and sounds and took lots of pictures which were ready to be organized. In the third phase, the children were assigned to specific parts in the story and produced the final story with the help of the teacher. The final story was only made based on the drawings, pictures and sounds with no texts and presented to the parents.



**Figure 2.6: (a) children draw on the iPad, (b) hand drawing and (c) captured drawings
(Rubegni and Landoni, 2018)**

This study demonstrated that technology usage in a formal educational context and digital storytelling improved children's engagement and motivation. Moreover, working as a group encouraged the children to interact with others and share their ideas, which improved their social interaction, self-awareness and emotional development. Also, this study demonstrated that digital storytelling has a positive effect on children who have language or communication problems or self-expression problems when they record their voices. This study is well organized and contains a valid approach to designing an authoring tool for pre-literate children. However, it is restricted by a small sample size (15 pupils). It also used a set of pre-existing applications rather than designing its own framework; which was overwhelming and caused a cognitive overload for infant school children when they moved from one app to another. Therefore, the system has the potential to overwhelm the children. Although they enjoyed taking pictures, drawing, recording and etc., they felt limited when combining these together. Moreover, the children cannot use these tools by themselves as they require guidance and supervision by their teachers or another adult. The qualitative approach gave feedback on enjoyment and usability, but could not give detailed information on attainment. Therefore, there is a need to examine the effect of this system on student attainment and understanding.

In their study, Zhou and Yadav (2017) aimed at examining the effect of digital storytelling, reading and questioning on preschoolers' literacy skills, including their reading engagement, vocabulary acquisition and story comprehension compared to story reading in print. The participants were 72 preschoolers aged between 4-5 years old. This study used a 2 (multimedia

vs. paper) X 2 (question vs. no question) design where participants were randomly assigned to one of the four groups i.e., (1) paper storytelling with questioning, (2) paper storytelling with no questioning, (3) multimedia storytelling with questioning and (4) multimedia storytelling with no questioning conditions. In group 1, the researcher read the story to the children, and asked them questions about the story after reading the story. In group 2 the story was read by the researcher without asking the children any questions about the story. In group 3, the participants read the story independently from the iPad application using the read-aloud feature along with interacting with the objects in the story as well as the researcher asking them questions. It was the same for group 4 but no questioning was involved.

This study used Woodcock-Johnson III picture vocabulary test and the target vocabulary test (Collins, 2010) as pre-tests before the children started the reading sessions and the participants received 2 reading sessions over two-weeks. All the sessions were video-recorded to observe the children's engagement. After the sessions, the participants received 18 target words from the Polar Bear Horizon story post-test and a story comprehension test which consist of six open-ended questions; three direct questions about the story and three asking the children to summarize the story. The target vocabulary in the pre-test and post-test was identical. The multimedia story selected for the experiment was the Polar Bear Horizon storybook application (see Figure 2.7) on the iPad which combined between text and narrative; and when the child touched the illustrations on the screen a read aloud feature played and the word appeared on the top of the page, the story was also highlighted while the text was read. The paper version was the same story but in printed form and had the same pictures as in the multimedia story.

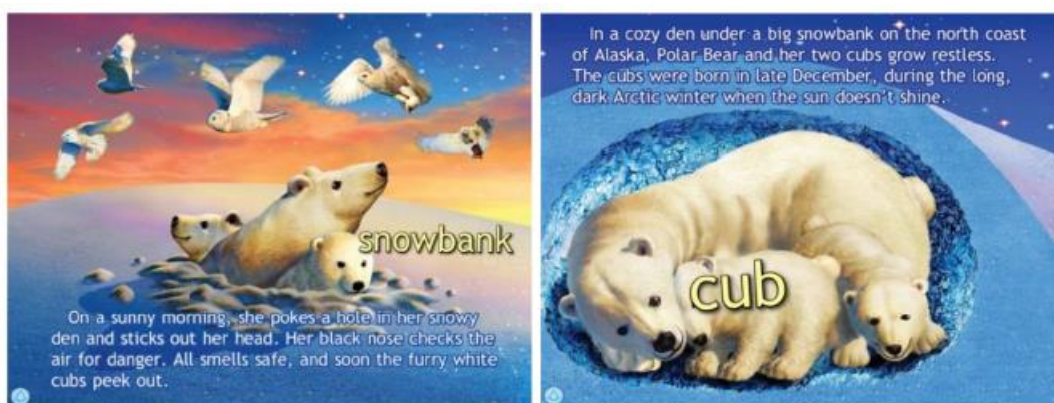


Figure 2.7: Screenshot of the Polar Bear Horizon story (Zhou and Yadav, 2017)

The results demonstrated that in the comprehension test, there was no main effect for using multimedia or questioning children on comprehension. Also, the results showed that there was no significant variation in vocabulary learning between the multimedia group who received

questions, and the paper group who received questions. The result also indicated that the children in the paper group who were asked questions performed better than children in the paper group with no questions. In contrast to this, there was no significant differences between the children group who used the multimedia story with and without questioning in vocabulary learning. The results also indicates that the multimedia stories based on the touch devices have significantly improved children's vocabulary and have the same effect as paper stories with a questioning approach.

This study was well-organized and used qualitative and quantitative methods to examine the effectiveness of multimedia reading story on preschool literacy skills. It compared between multimedia and printed stories as well as the effect of questioning and non-questioning in its design, and showed positive results for understanding how DST can enhance children's reading abilities. Although the children in the multimedia group could work independently, there was only a small interaction between the children and the multimedia story. Also, this appears to be a fairly simple application based around a single story where the story is predefined. There is no story- building here it just appears that children can have certain words shown and a read-aloud feature that narrates the story. Moreover, this study focuses on individual words rather than story structure. This study also involved the researcher asking the questions rather than presenting the questions in the screen.

Rubegni and Landoni (2014), completed a study aimed at investigating the effect of their iPad application called Fiabot! on student local/first language writing and whether the application designed supported students in achieving curriculum objectives. The participants were 43 children aged 9–11 from grades 4 and 5 and their teachers from two different primary schools. This study used qualitative research methods such as interviews, focus groups and observation. The application consists of three stages, as shown in Figure 2.8: The first stage is where students define and create the plot of their stories. Therefore, the application provides a model of the story structure based on the curriculum. The elements of the story were grouped based on story genre as a list of ingredients; for example, the fairy tale story consisted of different elements such as the protagonist, the antagonist, their helpers and the magic objects. The second stage is creating the story, where students can create, import and edit different types of multimedia such as images, videos and audio from the internet or from the device by using the camera to take pictures of the hand drawings. The third stage is where the students share and publish their stories to an external website with a password.



Figure 2.8: Screenshots of Fiabot! mobile storytelling application (Rubegni and Landoni, 2014)

This study showed that this application met the curriculum requirements, which will support the teaching and learning process. The qualitative analysis of this study showed that this application increased teachers' self-esteem and awareness about using the technology in their teaching. It also helped the children to achieve the specified objectives and they were very enthusiastic about creating magic stories. Moreover, the children felt that they had control over their learning as they were responsible for producing the final story. Therefore, the application increased the students' satisfaction and self-esteem.

This study, in general, was well-structured, and showed how the system was used by both students and teachers, as well as explaining the effectiveness of using such a system in formal educational settings. However, the researchers used only a qualitative approach to examine the effectiveness of the app and they did not show how they assessed or measured the system's effectiveness on students' learning. Also, it required a long time for the students to import pictures, audio or videos to create the story, which could be a complex process for some of them. Although students could share their stories, the application did not allow them to comment on each other's stories.

Hwang et al. (2016) examined the impact of storytelling and multimedia on enhancing speaking skills and learning language when students learn English as a foreign language. The researchers asked students to speak English when they produced their own stories by using a web multimedia system. The study used cognitive theory as a theoretical framework and the system was developed specifically for this study and to support designed learning activities. The developed system has two functions: Story Editor, which has three parts; (1) a toolbar, (2) a content area, and (3) a vocabulary area, and Story Player, as shown in Figure 2.9. Students can use the tool bar for adding, editing and deleting scenes for the story, adding text to the story, recording their voices over the story, uploading photos or audio to the story, animating objects in the story; and can preview the story through Story Player, and save and share the story. The vocabulary area contains provided words where students can listen to each word by pressing on them.

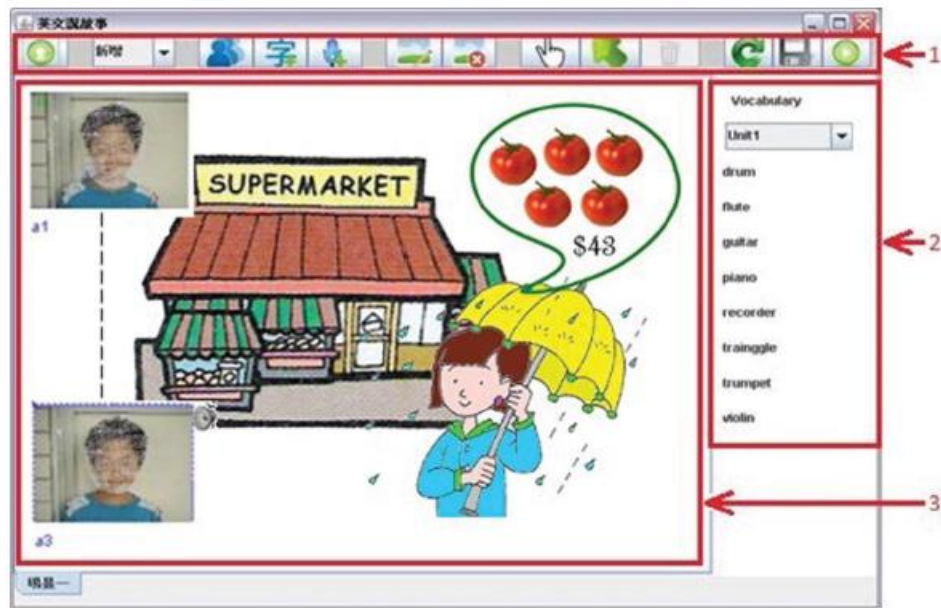


Figure 2.9: Screenshot of Story Editor and Story Player (Hwang et al, 2016)

The study used pre and post-tests created by the teacher for both the experimental and control groups to measure the system's effectiveness on students' speaking, as well as questionnaires and interviews when the experiment was over to understand students' perception about the use of the system. The participants were 59 primary school students in sixth grade; with 30 students in the experimental group and 29 in the control group. All students received one-hour EFL lessons three times a week over six weeks. The control group invented stories using traditional methods i.e., pen and paper while the experimental group used the developed system. The results showed that the developed system increased students' motivation, imagination and creativity. The experimental group performed in the post-test better than the control group in their speaking performance. Moreover, most of the students had positive attitudes and perceptions towards using the system. This study developed an authoring tool that allowed the students to create and record their sounds in order to develop their own storytelling. It is also used pre and post-tests to measure the effectiveness of the system on the experimental group and compare their results with those of the control group. The post-test results suggested that this application had improved speaking skills for the experimental group. However, even though it allowed the students to share their stories with others in the same classroom, it did not allow them to provide feedback. Moreover, the system here is fairly basic in that it is just around a single story rather than the several stages building up to a story, limiting the scope of the story.

Molnar (2018), examined the effect of digital storytelling on students' interactions in a microbiology class. The participants of this study were two classes at a secondary school where the students were allocated to an experimental and a control group. The control group used a version of storytelling that did not use gamification and a leaderboard, while the experimental group used the interactive digital storytelling system that used gamification and a leaderboard. The researcher observed the students during the study. The storytelling in this study is a problem-based learning approach where the players and their partners try to solve a problem, for example, deciding who has poisoned the famous actor. They try to find the guilty person while they learn different biological facts to help them solve the case. This storytelling is interactive as it changes according to the players' actions. The storytelling is completed when the players have found the guilty person. The students are asked to provide a nickname if they want to be shown in the leaderboard. Every time the players answer the question correctly, they are given points that appear in the leaderboard, which is to motivate the students and allow them compare their performance with each other, as shown in Figure 2.10.

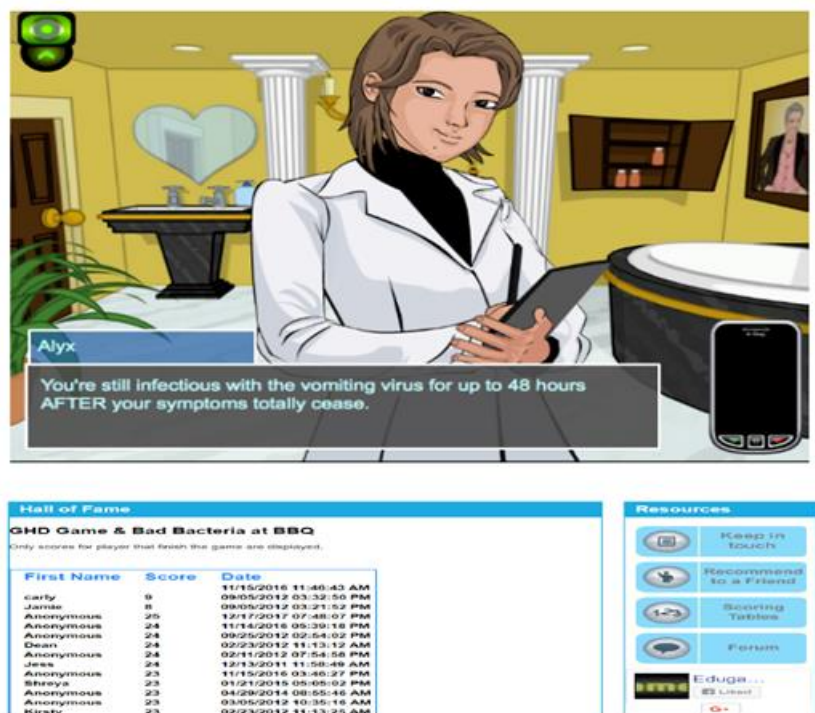


Figure 2.10: Screenshot of the storytelling, gamification and leaderboard (Molnar, 2018)

This study showed that interactive digital storytelling and gamification increased students' discussion in the classroom based on the learning objectives taught. This is a case study which implemented interactive digital storytelling in a microbiology class. It used the problem-solving approach which allows the students to brainstorm in order to find a solution, which in

turn helps the students to recall the information. Even though the interactive storytelling was changed based on the students' actions, it did not allow them to create their own story as these actions were limited and predictable. It also did not allow them to share their created stories. The authors did not mention how big the sample size was in order to generalize their results; nor did the study measure the effectiveness of the system on students' learning.

Al-Mousawi and Alsumait (2012), examined the effect of a storytelling tool on improving children's communication skills. The participants were 73 Arab children aged 4-5 years old from private and public kindergartens. This study used a mixture of qualitative and quantitative approaches; a questionnaire (where testers asked the children questions and recorded their answers using a Likert scale), interviews and observations. The system consists of 3 main components: Firstly, objects which could be characters, elements or animals. Each scenario has set of related objects. Secondly, sound effects which consist on two effects: background or scene effects for the story and effects for objects, such as the sound of a car engine; Finally, there are scenes which provide the story's background, such as place and time. Each scenario consists of a set of scenes and the children are able to re-arrange them to match their stories. The child can choose either to create a story, listen to saved stories, or add an ending to a story. If children choose the creation option, they can choose from available scenarios and then start the story scene by dragging and dropping objects, record their voices to tell a story and save the created story. Then the child has the option to listen to the previously made stories, as shown in Figure 2.11.



Figure 2.11: Screenshot of Arabic storytelling tool (Al-Mousawi and Alsumait, 2012)

The results showed that the children were interested in using the new technologies, especially because none of them had difficulties while using the tool; and all of them were completely engaged. The results demonstrated that 4-year-old children were self-confident, more interactive and creative while 5-year-old children are more conservative, because, as they became bigger, they start to learn how to control their actions and therefore limit their freedom of expression. Moreover, gender differences between preschoolers' results were very small. This study provided an authoring tool for children to create their own stories by dragging and dropping predefined items into the scene. They also could record their voices while narrating their stories. However, this research was centred on story-telling and was not specifically linked to children's learning of a specific subject or language.

Cordero et al (2015) developed a tablet-based application for third year primary school students to enhance their reading and writing. This app was named 'Read Create Share' (RCS) and was a three-phase reading, drawing and writing application. The first phase was reading, where the application provided the user with texts to read, but required completion through a game activity (where the user locates 3 hidden objects in the illustration and drags and drops them into the backpack on the screen. The second phase was creating, where the user creates a picture based on the selected items that they put in the backpack from the reading. The three selected items appear on the screen and the user needs to select the preferred item and add their own drawings to it. The third phase is sharing or writing, where the user narrates the pictures they have created by recording their voice or by writing a caption with the keyboard, as shown in Figure 2.12.

The content of the application was based on the children's book called 'Didi Recorrer Nueva York' (Didi Tours New York). The texts in the application were not linked therefore the user could read the texts in a different order.



Figure 2.12: Screenshot for the Read Create Share (RCS) application (Cordero et al, 2015)

This study used design-based research, and the participants were 136 third-grade primary school students (74 boys and 62 girls). The observation process was done through two research assistants observing each student. One of them was guiding the student while using the application and the other was observing and taking notes about the system's usability and the students' behavior. This study showed that the developed system helped in engaging the students while they learnt reading and writing. Students were creative, although many of them ignored the instructions of the observers; therefore, this application needed to be used with the teacher's supervision. This study produced an interactive application that supported students' reading and writing at the same time. It has many features: such as a gaming element, drag and drop, voice recording, keyboard typing and the facility for children to draw their own pictures. However, one of the limitations is that the authors did not link the content of the system to the curriculum content. Also, the study did not measure the system's effectiveness on the students' reading and writing.

Sarica and Usluel (2016) conducted a study to examine the effectiveness of digital storytelling on students' visual memory and writing skills. It used a pretest – post-test control group design and was conducted over 13 weeks. The participants were 59 primary school students in the

second grade who were enrolled in the 'Journey of Myself' education programme. The experimental group had 29 students while the control group had 30 students. The pre- and post-tests were based on the 'Composition (Written Narrative) Evaluation Scale' (Sever, 2004) and the 'Benton Visual Retention Test' (Sivan, 1992) which aimed at examining the capacity of the visual short-term memory of the students. The students in the experimental group created their stories as follows: Each student planned the story and discussed it with other students. Then, the student was given an A4 paper on which to write the story. After that, students were asked to write their stories line by line in order to edit them, add to them or remove from them. Then, students were asked to prepare the visuals they wanted to use to support their stories, and draw them on the paper, as shown in Figure 2.13. The students were then asked to order their stories. In addition, the students divided into groups and then were provided with a tablet; they selected their preferred open-source application to do their drawings and then they voice-recorded their stories on these drawings by using Audacity and produced their stories by using the 'Microsoft Photo Story' and 'Movie Maker' programs. Finally, the digital stories of all the students were copied onto CDs to be presented to their parents, school teachers and the school's administration. However, the control group were asked to present a poster as there were no activities for digital storytelling,

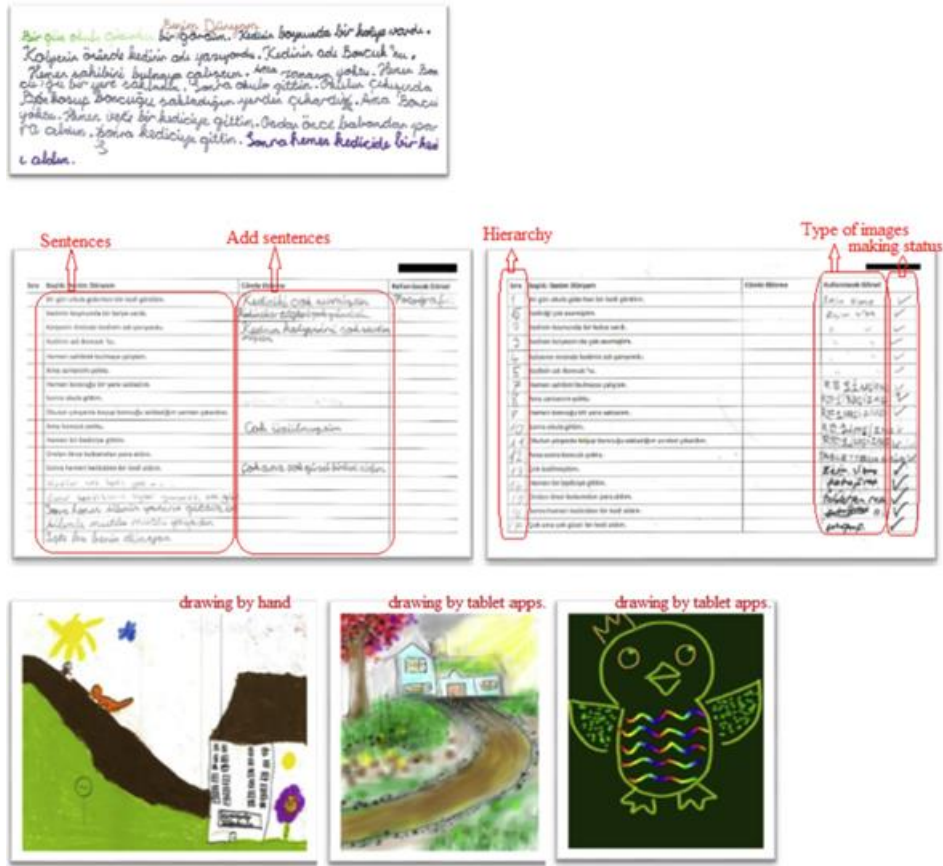


Figure 2.13: Digital storytelling to exercise students' visual memory and writing skills (Sarica and Usuel, 2016)

From the observation and informal interviews with the students, the study showed that students in the experimental group enjoyed the story creation process. Moreover, both groups showed a significant improvement in their writing skills and visual memory capacity. There was no statistically significant variation between the groups for visual memory capacity, but there was a statistically significant difference in the writing skills of the experimental group compared to the control group.

From the above research it is possible to see that although significant work has been done in the area of digital storytelling and the studies show key improvements in engagement and in some cases achievement, the systems developed are currently limited. Additionally, the studies mainly involve qualitative analysis with only a few studies using quantitative tests to assess impact. There is also a significant lack of studies that use digital storytelling in the Arab context, especially in Saudi Arabia. Further, there is a lack of studies that have applied digital storytelling in line with the formal school curriculum.

2.4 Universal Design for Learning (UDL)

It is common for the classroom to have a diverse set of students who have different backgrounds, experience, knowledge and culture as well as linguistic diversity. Therefore, they vary in the way they communicate and interact with each other, as well as in their understanding and information processing skills and they may have different approaches to completing tasks (Rao and Meo, 2016). This wide variety of students can make the classroom an enriched environment for learning, but can highlight problems with the traditional teaching methods and raise challenges for teachers, as it makes it difficult for teachers to design instruction and plan for lessons to meet diverse needs of all learners (Rao and Meo, 2016; Capp, 2017; Kumar and Wideman, 2014). Thus, there is a need for new methods of teaching and learning to overcome these diversity challenges.

The traditional teaching approaches standardize the learning process and one-size-fits-all curriculums are not always the best approach in educating pupils because this way of learning does not consider the differences between learners' individual abilities (Rogers-Shaw et al., 2018) and does not lead to achievement or engagement for all students whether they have disabilities or not (Capp, 2017). Rogers-Shaw et al. (2018) stated that traditional learning methods such as standard materials, assessment strategies and text-based discussions do not meet learners' differences, needs and demands, especially for students with disabilities or language barriers who are less successful in school. Therefore, the learning environment should be inclusive for all learners by making the learning materials accessible to every learner. UDL is a promising way to meet different learners' needs and make learning materials accessible for diverse student populations (Kumar and Wideman, 2014; Rogers-Shaw et al., 2018). This in turn helps to shift the focus to the disabled curriculum rather than the disabled student and to shift educational practice from teacher-centred to student-centred approaches (Rogers-Shaw et al., 2018) which can benefit both the students and their teachers.

Rao and Meo (2016) considered UDL as a framework for designing and implementing flexible instruction along with support for addressing student variability within the classroom context. This does not mean that teachers have to design unique instruction for each student specifically; teachers can predict some of their students' variability and where they will vary, along with considering potential barriers that may students face to achieve the lessons goals (Capp, 2017). Teachers can then include flexible options to support learners' variability in the class, which will improve the learning process for every student and reduce the barriers for students that have disabilities (Capp, 2017).

Cook (2018) noted that the UDL framework is used to deliver class instruction for all learners and to target individual needs for students with learning disabilities rather than modifying the instruction for specific learners. The Center for Applied Special Technology (CAST) notes: “...the UDL educational framework guides the design of instructional goals, assessments, methods, and materials that can be customized and adjusted to meet individual needs” (CAST, 2018).

The UDL framework was developed by David Rose and his team from Harvard University (Rose and Meyer, 2002, cited in Katz and Sokal, 2016). This idea was developed based on the concept of universal design which proposed by Ron Mace in the field of architecture in the 1970s (Null, 1995). This concept aimed at designing building structures with supporting features to be used by people with different abilities, especially people with specific needs, to access these building independently and immediately without the need to modify them (King-Sears, 2009; Center for Universal Design, 1997).

The Center for Applied Special Technology (CAST) began to develop UDL in the early 1990s to be applied to designing curriculum and instructional practices in order to reduce the barriers within them (Hitchcock et al., 2002). CAST (2018) stated that “Universal Design for Learning (UDL) is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn”. They state that UDL has three principles, nine guidelines and 31 checkpoints (see Figure 2.14):

The three guiding principles are:

1. *Multiple means of representations.* This means representing knowledge to students in multiple ways in the learning process, as there is no one means that is considered as an optimal approach that works for all students. Therefore, the learning barriers are reduced in the classroom and knowledge is delivered to all learners regardless of their backgrounds, abilities and learning styles. (CAST, 2018; Capp, 2017).
2. *Multiple means of action and expression.* This means the students are allowed to demonstrate their knowledge, understanding and actions in different ways, as there is no one means that is considered as an optimal that works for all students. Therefore, providing these means should differ based on the learners’ preferences. By doing this, the students control their learning and activities and are engaged effectively (CAST, 2018; Capp, 2017).

3. *Multiple means of engagement*: This means the existence of different ways of engaging students with the learning materials, as the students vary in the ways they are engaged in the learning process and motivated to learn (CAST, 2018; Capp, 2017).

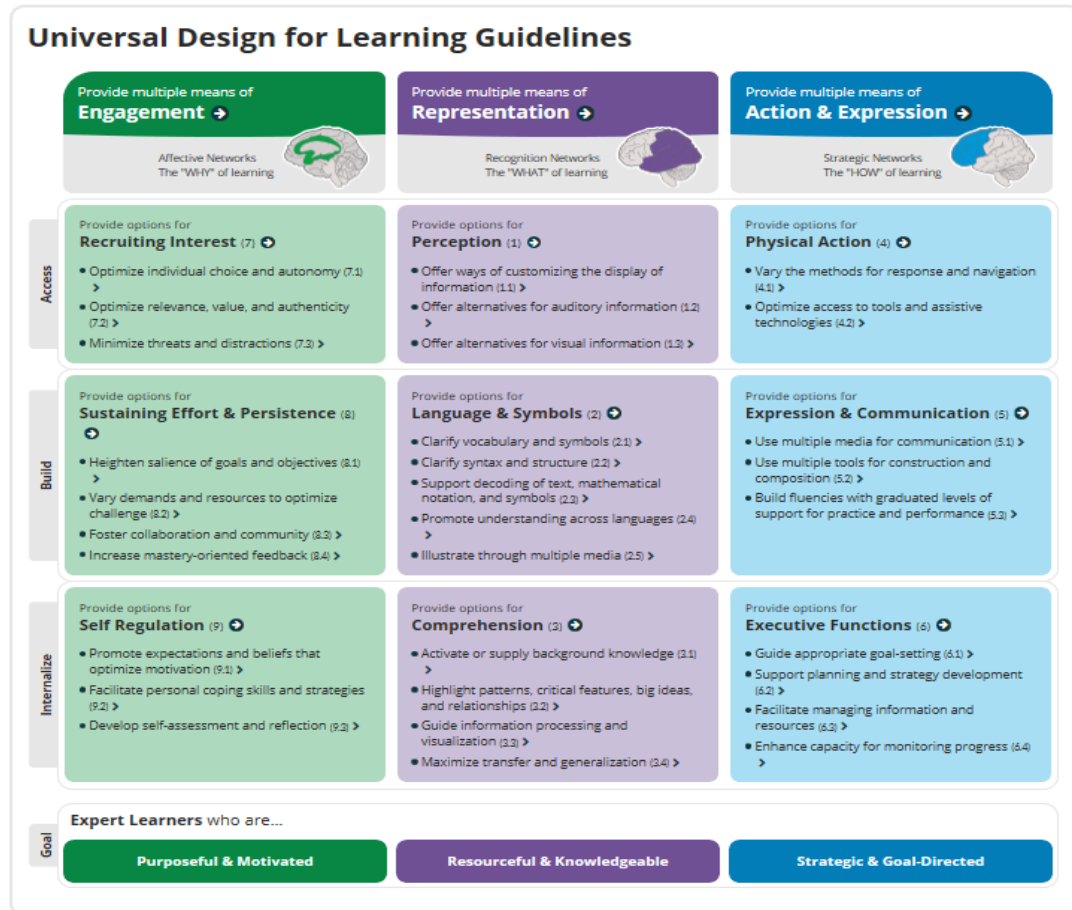


Figure 2.14: UDL guidelines based on CAST (2018)

These aforementioned principles are designed based on research in cognitive neuroscience, which found that students varied in processing information. For example, the recognition networks are linked to the first principle; the strategic networks are linked to the second principle; and the affective network is linked to the last principle. Therefore, these learning networks interact together and allow each individual to perceive, express and recognize information learned (CAST, 2018; Kang et al, 2018).

Many researchers support the idea that UDL can be used in the planning of standard lessons, but its application can be promoted when combined with educational technology for creating flexible learning environments (Al-Azawei et al., 2017; Rao and Meo, 2016) especially for students with learning disabilities (King-Sears, 2009). The UDL framework can provide materials that contain a combination of multimodal information such as audio, video and text.

A study by Hitchcock et al. (2016), noted that the use of technology along with UDL can benefit students who have language problems, struggle with writing or cannot express their own knowledge by writing words, as they can when they asked to use visual and oral techniques.

Many studies have implemented UDL in Higher Education to improve online courses in distance education (Rogers-Shaw et al., 2018; Dell 2015), at the Aviation Laboratory to train students (Kang, 2018), on an e-biology course (Bryans Bongey et al., 2010), a health science course (Kumar and Wideman, 2014), for teacher education (He, 2014), teacher training (Navarro et al., 2016) and computer science (Al-Azawei et al., 2017). There are some studies that have applied UDL at school level on courses such as ‘Writing for Science’ (Hitchcock et al., 2016), chemistry (King-Sears et al., 2015), reading (Narkon, and Wells, 2013; Meo, 2008) and literacy (Coyne et al., 2012). These studies indicated that UDL has positive results and increases students’ flexibility and success as well as reducing stress (Kumar and Wideman, 2014). It brings a great accessibility and enjoyment for all learners in the learning process and helps students to enhance their abilities in understanding and using the new knowledge (Rogers-Shaw et al., 2018). Students who attend courses that use UDL described positive attitudes towards their course, high satisfaction and engagement (Al-Azawei et al., 2016).

Almumen (2020) conducted a qualitative study with five school teachers from different grade levels to investigate the role of UDL on students’ ability to learn and gain knowledge in the classroom via observing the teachers’ practice and how they implemented UDL in their lessons. The results indicated that UDL was successful in engaging all the students with and without disabilities but the teachers needed more training in using UDL to address the needs of their students. Alquraini and Rao (2020) conducted a study to explore the perceived knowledge of teachers about UDL in special education schools in Saudi Arabia, and their needs to implement UDL successfully in classrooms. This study showed that there were challenges that teachers faced, they needed more training, lacked planning time and knowledge about UDL and had to deal with large class sizes. Alasalem (2015) mainly explored the effect of a training programme on teachers of profoundly deaf students and students with hearing impairments, and judged their perceptions about implementing UDL. The results showed that teachers were willing to know more about UDL and adopt it in their classes as they thought it had a positive effect on their skills and knowledge.

Al-Azawei et al. (2017) examined the effect of implementing UDL principles on a technology-enhanced traditional web design course on learner satisfaction and the acceptance of blended e-learning. This study used a mixed research design that used a survey and action methods. The participants were 92 second year undergraduates aged between 18 to 22 students who were studying a computer science module called 'web design in public' and were considered as the experimental group; while the control group consisted of 77 second year undergraduate students from the previous academic year. Both groups experienced Moodle and completed a survey. The control group studied traditional blended E-learning while the experimental group used UDL-based blended E-learning. UDL was used in designing the first five lectures of the course which were delivered through blended learning and Moodle as follows:

Multiple means of representation. The course content was presented in a wide range of formats such as PDF, PowerPoint slides, Word and video. Lectures were uploaded to Moodle two days before the class to give students enough time to review them. During the class session, the tutor presented the information in many ways such as group discussion, DataShow, Q&A sessions and PowerPoint slides, according to students' preferences.

Multiple means of action and expression. The learning evaluation used different methods to allow students to represent their knowledge by using different means such as two theoretical exams, an individual project, a laboratory test, four self-assessments and a final exam.

Multiple means of engagement. This was done through posting the course overview through Moodle and notify the students about upcoming activities through the announcement page to keep them updated. Also, the tutor posted questions related to the classes in the course forum to keep students' interest in the course and replied to questions quickly. Moreover, self-assessment tests gave students direct feedback for each question. During the class session, activities between the tutor and the other peers were designed to encourage the students to participate in the class. Also, tutor feedback was given to the students regarding their projects and assignments.

The results demonstrated that designing curricula according to UDL increased learners' perceptions and engagement, and reduced learning stress. Students remarked that this course had enhanced their interaction with the learning materials, academic achievement and understanding of the course. Also, the experimental group had a greater willingness to adopt e-learning than the control group. Although this study applied UDL principles in designing the course, it was not a practical application of UDL. It also did not quantitatively measure the

effect of UDL in designing the course on students' learning for example by using pre and post-tests.

Narkon and Wells (2013), studied the effect of applying UDL to the instructional design of story-mapping lessons on reading comprehension in English for elementary students with a reading disability. This study applied UDL principles as follows:

Multiple means of representation: The teacher selected the narrative book that contained the story-mapping elements and then displayed them using the projector or whiteboard, and provided all students with a copy of the book. The teacher asked the students to discover the characters, the relation between the characters and the place of the story from just looking at the cover of the book.

Multiple means of action and expression: The teacher used different strategies for students who faced difficulties in writing by use of the story map template, (see Figure 2.15) a word processor in the desktop or drawing their response.

Multiple means of engagement: Students were given the choice of working individually, in pairs or in a group. Also, they were given the opportunity to use the software in the desktop to organize their story map.

MY STORY MAP

	Story Title:	
	Main Character(s) (Who?)	
	Setting (Where? When?)	
	Problem/Conflict?	
	Major Events (What happens?)	1. _____ 2. _____ 3. _____ 4. _____
	Story Outcome (How do they solve the problem?)	_____ _____

Figure 2.15: Applying UDL and story map template in the instructional design lesson (Narkon and Wells, 2013)

This study illustrated the application of UDL principles in the instructional design of a story-mapping lesson, which resulted in a rise in students with learning disabilities engaging and

interacting with the content, which helped them to achieve the learning objectives. In this study, the authors did not mention how they measured the effectiveness of their study on students' engagement and interaction. Also, there was no information about the sample size and the participants.

Although much research has been published regarding the usefulness and applications of UDL as a framework, most of the current research includes different levels of descriptive information that uses UDL as an instructional design framework and course design theoretically. Moreover, UDL studies are generally limited to a few countries, with only small-scale studies conducted in Arab countries such as Kawait (Almumen, 2020), and Saudi Arabia (Alquraini and Rao, 2020; Alsalem, 2015). Moreover, at the time of writing, there are no studies that have implemented UDL for teaching Arabic. Therefore, there is a clear need for a practical application that incorporates UDL for teaching Arabic in Saudi schools.

2.5 Reading Fluency and Comprehension

Many researchers mentioned that all children have the right to be literate regardless of their gender or disability (Peters, 2007; Rousso, 2003; Snowling and Hulme, 2012). Reading is an important literacy skill, which in turn opens doors to further education and employment (Snowling and Hulme, 2012) and which leads to social and economic advancements. It is a complex and critical skill because formal education is almost completely based on the ability to read and understanding (Hulme and Snowling, 2011; Snowling and Hulme, 2012). Therefore, the main goal of teaching children in early education is to learn reading by decoding words and understanding their meaning (Hulme and Snowling, 2011). It is expected in developed education systems that a child should be able to read fluently and understand texts by the end of their time at primary school (Snowling and Hulme, 2012).

Reading is about gaining access to the meaning of text (Kameenui, 1999) and is based on decoding and comprehension skills (as discussed later) (Hulme and Snowling, 2011). Additionally, reading requires two skills in order to be an automatic process, fluency and comprehension (Snowling and Hulme, 2021). The National Reading Panel in the United States (2000), also state that fluency is considered as a vital part of reading, and comprehension is the essence of reading. Veenendaal et al. (2015) stated that reading fluency can lead to success in reading comprehension, which is the ultimate aim of reading development. Fluent children are able to read text with accuracy, speed and proper expression (Klauda and Guthrie, 2008;

National Reading Panel, 2000). Therefore, they must decode words accurately with an adequate speed if they are to retain them for comprehension (Therrien, 2004).

Reading ability is a result of performing two tasks; decoding and comprehension (Gough and Tunmer, 1986; Hulme and Snowling, 2011). Decoding is the ability to translate the printed words, while comprehension is the ability understand the decoded text and construct the meaning from it (Snowling and Hulme, 2021). Decoding and comprehension skills are related (Snowling and Hulme, 2021). Therefore, children who have difficulties in reading fluently will read slowly with huge amount of effort regardless of how smart they are (National Reading Panel, 2000) because fluency problems occur when the reader has poor decoding skills (National Reading Panel, 2000; Therrien, 2004) which in turn will affect the comprehension process. This is supported by the National Reading Panel (2000), who state that problems in reading fluently interfere with reading comprehension because the reading process occurs based on two cognitive tasks: firstly, recognizing the printed text (i.e., decoding) and then extracting the meaning of that text (i.e., comprehension). Both tasks require cognitive resources which are restricted by the memory's limit. For example, if the process of recognizing the text is hard and slow, it will obstruct comprehension as the whole cognitive resources will be consumed by the decoding task and leave nothing for the comprehension task (National Reading Panel, 2000; Therrien, 2004). With practice, the reader will decode the words quickly, thus consuming few cognitive resources and allowing the rest to focus on comprehension (National Reading Panel, 2000; Therrien, 2004; Stevens et al., 2017).

Difficulties in reading lead to difficulties in education (Therrien, 2004; Hulme and Snowling, 2011). Many studies agree that reading difficulties have a direct effect on educational achievement which in turn have negative social and economic impact (Hulme and Snowling, 2011; Therrien, 2004). According to Snowling and Hulme, (2012) and Gough and Tunmer, (1986) there are two main reading disorders in children: difficulties with decoding (i.e., dyslexia) and with comprehension, i.e., having comprehension impairment (poor comprehenders) (Snowling and Hulme, 2021; Snowling, and Hulme, 2011).

Rahmani (2011, p.780) defined dyslexia as follows: "Dyslexia is evident when accurate and fluent word reading and/or spelling develops very incompletely or with great difficulty." Similarly, Snowling, and Hulme (2011) defined it as a reading problem that is linked with basic decoding and recoding (i.e., spelling) skills. Children who suffer from dyslexia have difficulties in linking the spelling of the words and their pronunciations. Those children read aloud slowly

and inaccurately along with having spelling problems (Snowling and Hulme, 2012). While children who have difficulties with comprehension sometimes can decode well (i.e., read accurately and fluently) but have difficulties in understanding what exactly they have read, along with poor grammar and vocabulary knowledge (Snowling and Hulme, 2012); Clarke et al., 2010). Those children are classified as poor comprehenders or having reading comprehension impairment (Snowling and Hulme, 2021). Based on Fletcher et al. (2019) dyslexia is a word level reading disability while comprehension impairment is a text level reading disability. Reading intervention can reduce reading difficulties and enhance reading abilities. Rahmani (2011), mentioned that the process of teaching and learning should be multisensory (i.e., visual, auditory and kinaesthetic) especially for children who suffer from dyslexia in order to help them to read successfully.

2.6 Summary

The previous research on mobile learning and its applications proves the effectiveness of M-learning in enhancing learning and teaching methods. Additionally, many studies have claimed digital storytelling has a positive impact on learners motivation and achievement. Moreover, many studies mentioned the benefits of UDL in creating flexible learning environments for all learners. Overall, mobile learning, digital storytelling and UDL are shown individually that they are effective means of enhancing learning. From the research above, only a little applied work has taken place in M-learning for Arabic and none with a combination of all three methods above. Therefore, there is a need for more support of this type for children learning Arabic. The research presented in this thesis will build on the combination of these three key components into a novel system that is hypothesized to make a positive impact on children's learning of Arabic.

Chapter 3: System Development

3.1 Introduction

As explained in Chapter Two, an educational mobile learning application is proposed based on three main dimensions, namely: mobile learning, digital storytelling and universal design for learning (UDL). The purpose of this research is to design a mobile learning application by integrating UDL principles and digital storytelling for reading in Arabic for primary school children. The developed system aims to increase students' fluency, comprehension, engagement and satisfaction; and this chapter examines the design of this novel application.

3.2 System architecture

The first part was a mobile application which was developed using Visual Studio Tools for Apache Cordova in Visual Studio. It allows to build cross platform apps that run on iOS, Android, and Windows devices using JavaScript and plugins that allow to access many native features of the devices. There are many plugins used in this mobile application such as splash screen plugin, which displays and hides a splash screen when the application is launching, media capture plugin to provide access to the device's audio and video capture capabilities and finally screen recording plugin, which requests the user to grant the permission before the screen is being recorded.

The second part was a WebAPI which was developed using ASP.NET Core Web API and C# in Visual Studio to build a service that reaches and links between different clients such as the browsers and mobile devices. Therefore, the recorded videos can be shared and displayed in the bespoke website. Finally, the website, which was built using HTML, CSS and JavaScript to display the videos that shared by the users. All of these applications were built by the author.

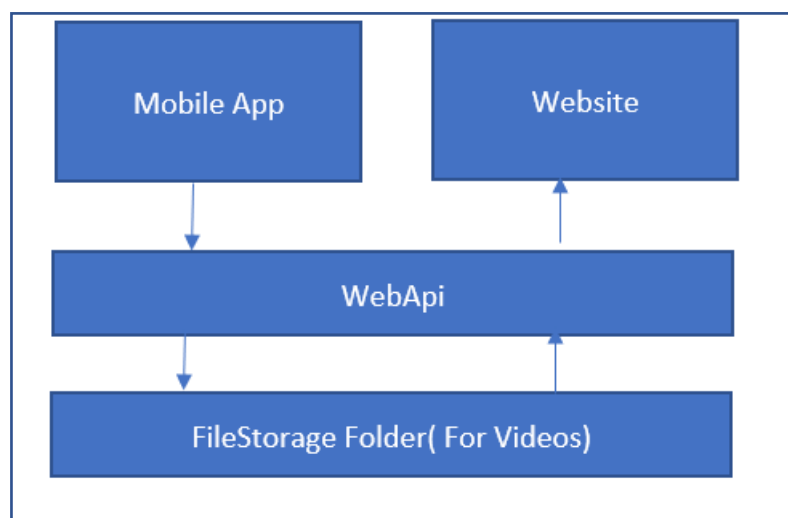


Figure 3.1: System Architecture

The mobile app was designed based on UDL principles and information acquired from the literature. Universal design for learning (UDL) is a framework to improve teaching and learning for all learners with or without learning disabilities, and targets the individual needs of learners. UDL has three principles as follows:

- 1- **Multiple means of representation:** As information is represented in multiple ways in the learning process, the relevant knowledge can be delivered to all learners. The displayed information will be represented in visual and auditory description to make the information accessible to all learners especially for learners with hearing or visual disabilities.
- 2- **Multiple means of action and expression:** Learners should express their knowledge in different ways to assist them as they practice and develop independence by offering them degrees of freedom to progress from easy to dramatic production, they can therefore control and synthesize their learning and engage more effectively. Moreover, providing feedback to give the learners a clear picture of their progress they are making therefore they can monitor their own progress and effort. This could happen by asking questions and providing prompts to advise them.
- 3- **Multiple means of engagement:** Different ways for learners to engage should be provided. To ensure engagement, learners should be provided with choices such as challenges, rewards or recognition, involving them in setting their own personal academic and behavioral goals, provide tasks that allow for active participation and include activities that foster the use of imagination to understand the complex ideas in creative ways.

The material for the app was based on the general teaching materials that are covered in the formal second grade book (iEN National Education Portal, 2019). The mobile app contained two parts: preparation and story creation as follows:

- i. The preparation part entails preparing pupils to read before starting to create a story, and it contains a section for words and a section for sentences. Each section has several pages that contain sets of words or sentences which are displayed with a descriptive picture and a read-aloud feature, which reads the word or sentences when the users click on it. Therefore, the pupils can listen as they read, if they want (see Figure 3.2 and Figure 3.3).



Figure 3.2: Preparation part (words page)



Figure 3.3: Preparation part (sentences page)

- ii. The story creation part has two levels of difficulty: Novice and Expert. This division enables pupils to progress through the process of creating story from a simple to a high level as follows:

The novice level: This level shows pictures and words at the top of the page and some questions to help the pupils to create a story by answering the questions via dragging items from a predefined list and dropping them into the draggable area for each question in order to answer it (see Figure 3.4a and Figure 3.4b). Immediate feedback is displayed if the pupil has dragged and dropped the wrong item in order to answer any question (see Figure 3.4c). When pupils have answered the questions, a short story with a read-aloud feature will be displayed based on their answers.

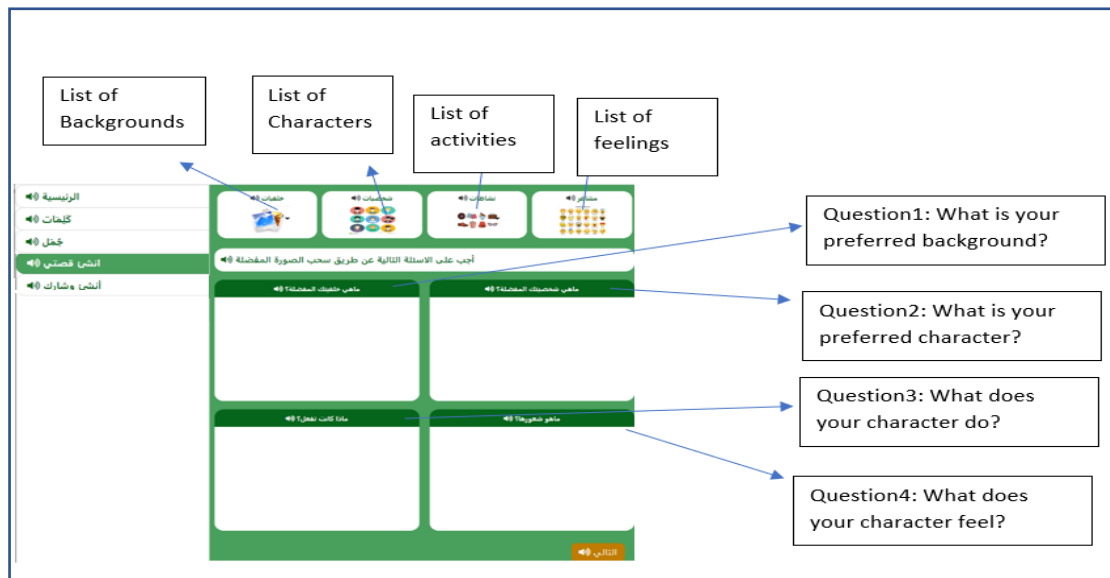


Figure 3.4a: The novice level



Figure 3.4b: Predefined lists of draggable items for children to create their stories. (From left to right: background list, character list, activity list and feelings list).

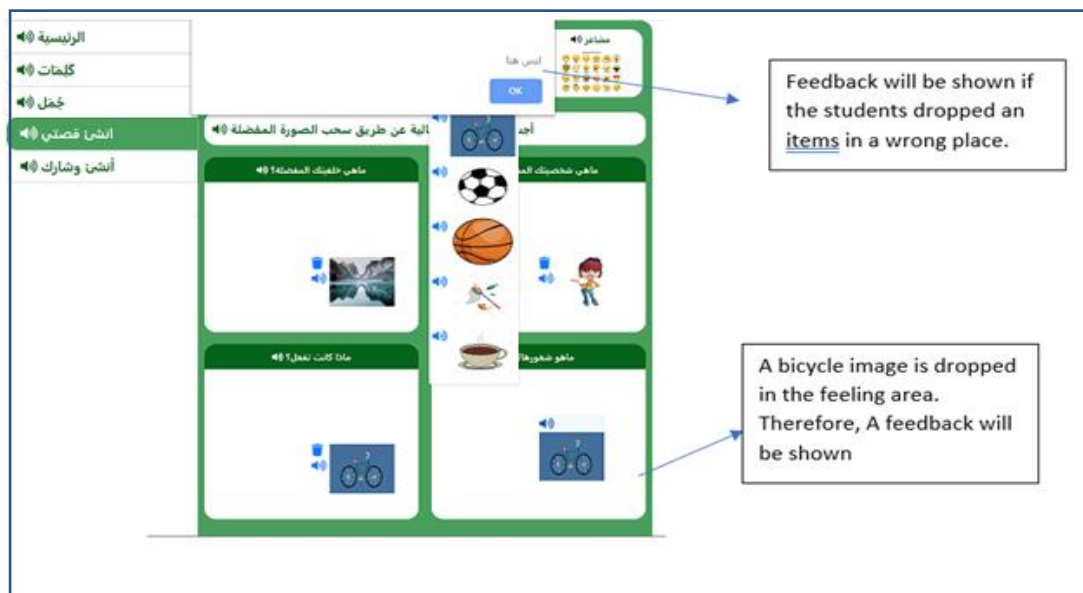


Figure 3.4c: Feedback for dropping the wrong item

The expert level: This level advances on the novice level by removing questions, so it encourages the pupils to use their imaginations and creative thinking to create a story (see Figure 3.5). The children are able to share their own stories on a website accessible to all the other pupils, and which enables them to be aware of their classmates' achievements.

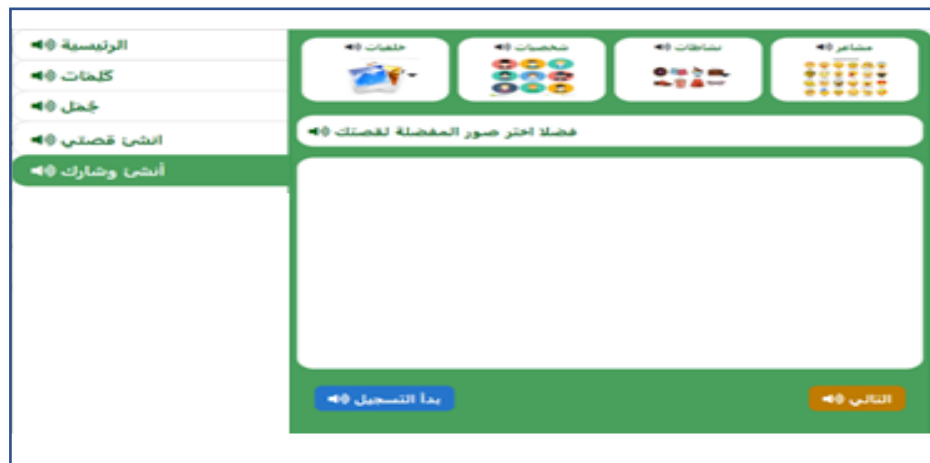
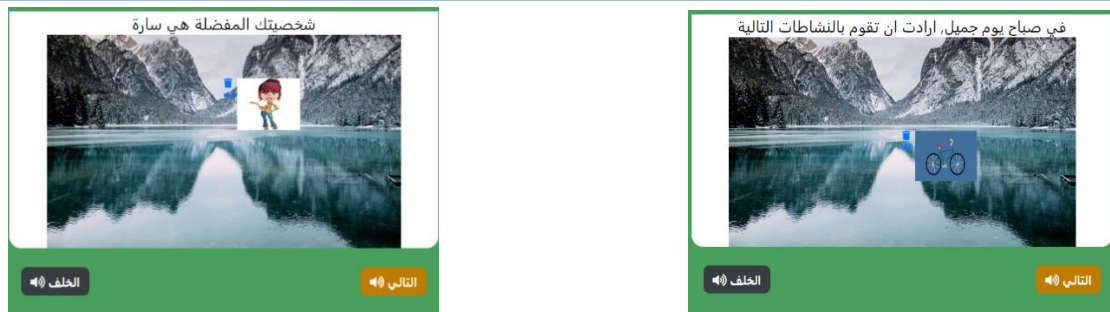


Figure 3.5: Expert level

The system was designed with a graded level of difficulty appropriate to the abilities of the pupils at this educational stage. Thus, although all the pupils can attempt the novice level, the expert level is designed to challenge pupils, and it is likely that not all pupils will be able to create a complete story at the expert level. The final story created by the pupils can appear in two versions. The first version is presented in a 'walk through' mode with separate pages for each element in the story, so that the character element, for example, with its text, picture and sound will be displayed separately on one page. When the user presses 'next', the rest of the of the components will be displayed separately in a similar way (see Figure 3.6: a, b and c).

The second version of the story will be displayed as a full version of the story on one page with supportive feedback and a supportive picture, and which indicate the end of this level (see Figure 3.6 d).



- a. Your preferred character is Sara b. One beautiful morning, she wanted to ride a bike



- c. She felt very happy because the weather was nice. d. The full version of the story of a,b,c.

Figure 3.6: An example of a story produced

3.3 Applying UDL in the system:

As discussed earlier, the mobile app design is based on the UDL principles as follows:

1. **Multiple means of presentation:** The app contains pictures, words and audio (the read-aloud feature). This will help learners with different learning styles and preferences to learn.
2. **Multiple means of expression and action:** Both the novice and the expert levels perform as an authoring tool (template) which is designed for creating digital storytelling so that learners can express their knowledge by developing and creating their own semi-bespoke story via drag-and-drop predefined pictures.
3. **Multiple means of engagement:** The app differentiates the difficulties and complexity with two different levels and subtly changes interaction styles, which supports learner engagement and the production of more complex stories from the novice to the expert level. In the novice level immediate feedback is provided on whether the dragged picture is dropped in correct place. At the expert level learners have much more free-rein to produce their stories and are able to share their stories with the class. This sharing of stories is a key supportive mechanism which will help them to be aware of each other's achievements, with the potential for them to critique each other's work.

The three above principles interact and work together to support learning. When the pupils use the system, they encounter a gradual progression from single words to sentences to simple stories and then more complex storytelling, whilst moving at their own pace. This progression enables pupils to form their ideas for their story and then extend it with the app giving them all the components they need to build the story. This has many benefits in the learning process such as increasing self-confidence and developing critical thinking skills.

This process is driven by the accessibility provided to the pupils by having the system available on mobile devices and informed by both UDL design principles and the engagement inherent in storytelling. In the traditional classroom, the teacher asks the children to read the words or short sentences or even to painstakingly write them, but in the app, they are being asked to interactively build a story, think about the story, and think about the elements that make up their story. This encourages them to use different advanced skills such as critical thinking and problem-solving to deliver their ideas to their audience, i.e., teachers and friends, but removes some of the common communication barriers associated with traditional classroom teaching. Therefore, when they produce the final story, they will have learned to think about and make narrative and editorial decisions regarding which pictures they want to include in their story. This is designed to encourage them to read their own created stories and enhance their reading skills.

3.4 Tablet specifications

For the purposes of this research the system will be accessible via tablets, although it is applicable to any mobile or touch screen device. The researcher purchased five tablets (Huawei MediaPad T3-10) for the purpose of the study as tools on which to run the mobile application. The specifications of the tablets are shown in Table 3.1 below:

Table 3.1 Tablet specification

Capacity	16 GB
Operating System	Android 7.0 Nougat
Screen Size	9.4 inches
Touchscreen	Yes
Wi-Fi	Yes

3.5 Summary

This chapter has described the design and development of the novel mobile learning application that combines digital storytelling and UDL along with its architecture and functionalities. The application of UDL principles to the system was described in detail. The app contains multiple means of representing the information such as pictures, words and audio. Moreover, the app is gradual where students progress from reading single words to sentences and creating their own stories and sharing them on a bespoke website to allow the learners to express their knowledge. Moreover, the app has two different levels of difficulty to support learner engagement and provides immediate feedback for the learners. All the three components of the e-learning system (mobile learning, digital storytelling and UDL) interact and work together to support the learning process.

Chapter 4: Pilot Study

4.1 Introduction

This chapter describes the pilot study performed using the developed mobile learning application that integrated digital storytelling and Universal design for learning. The main purpose of this pilot study was to ensure that the system was usable and to allow testing of the experimental methodology.

The experiment was conducted at the schools and the participants of this pilot study were second year primary school students in Makkah, Saudi Arabia. The participating students were divided randomly into groups of five for the practical sessions.

This chapter presents the use of the mixed research methods; Quantitative data analysis of the pilot study of both students and their parents surveys; Qualitative data was from teachers semi structured interviews, students focus group interview along with observations regarding student interaction with the developed system.

The results were concerned with the usability of the system and validity of the experimental methodology. The pilot study successfully demonstrated that the system worked, students liked it and enjoyed using it, and that the system was in-line with the curriculum and suitable for the student's ages. Students demonstrated a good level of technological experience and their parents were happy for them to use the system in the classroom.

The following subsections provide details about the pilot study such as the methodology, the participants, the experiment and the data analysis approach. The pilot study results are discussed in more detail at the end of this chapter.

4.2 Methodology

The study embraced both qualitative and quantitative approaches to investigate the answers to the research questions. The qualitative approach is based on semi-structure interviews (teachers and students) and observations (of students when they interact with the system). The quantitative approach is based on questionnaires (students and their parents) to examine the students prior knowledge of using technology and home literacy environment.

The pilot study has 3 experiments organized in 3 schools, with 4 classes, comprising 12 groups in 12 respective sessions within a period of 6 weeks. Each session lasted 45 minutes and was run at schools by the researcher. The questionnaire and interview questions of the pilot study were translated into Arabic language because it is the official language in Saudi Arabia.

Therefore, the feedback and interviews' answers from the participants are acquired in the Arabic language and then translated into English language for the purpose of this thesis.

4.3 Sampling Participants

The sampling method used in this pilot study was non-probability sampling. Non-probability sampling is a method of selecting participants in non-random way. There are two non-probability sampling methods used in this pilot study. Convenience sampling and purposive sampling. The convenience sampling (also known as opportunity sampling) is where the participants are selected based on their availability, convince and accessibility at the time. The purposive sampling (also known as selective sampling) is where the participants are chosen for a specific purpose based on the researcher judgment in order to participate (Cohen et al, 2013).

The participant of this pilot study are second year primary school children aged between 7 and 8 years old, their parents and four Arabic language female teachers in the first semester from three different primary schools (two public school and one private school) in Makkah city in Saudi Arabia. It is important to mention that the education system in Saudi Arabia segregates males from females in education because of its culture. Therefore, as a female researcher I normally only have access to female schools (see note on male students below).

This study has three experiments and the participants in these experiments were students whose parents had agreed and signed consent for their children's participation. The sample size of this study is 45 girls and 12 boys as follows:

- The first experiment was a class with 25 girls randomly chosen from set of classes (5 classes) in public primary school for girls only.
- The second experiment was in public school that applies The Early Childhood Schools Project, which mainly aims to ensure each child has an equitable and inclusive quality education by assigning boys at early school levels to female teachers (Ministry of Education, 2019). This project started in the first term in September 2019 and was applied in 55 public schools in Makkah region (Ministry of Education, 2019). The participants from this school were a whole class of 12 boys randomly chosen out of 2 classes and 10 girls non randomly chosen and selected based on their scores and engagements in Arabic language class as the top 5 and bottom 5 from one class.
- The third experiment took place in an International school where all subjects are in English and the Arabic curriculum follows the curricula for the Ministry of Education

in Saudi Arabia. The participants in this experiment were a whole class of 10 girls randomly chosen from two classes in the school.

This pilot study as a whole uses a small sample size with different groups of students from multiple schools to gain general information about the experimental methodology, system usability, students engagement with the system, the feedback from both students and their teachers on the system and to gain a general knowledge of children background of using technology.

4.4 Data collection methods

This study uses unstructured participant observations (Appendix 3.6) with recording field notes and two types of interviews: semi-structured interviews with the teachers (Appendix 3.5) and focus group interview with the children (Appendix 3.2) to collect information about the system usability and validity of the experimental methodology. It is also uses questionnaires for both students (Appendix 3.1) and their parents (Appendix 3.4) to obtain a general knowledge about students background of using technology and the way of reading at home.

The students interviews directly followed the practical session while the teachers interviews were scheduled in advance at a designated time during the normal school's opening hours and location inside the school that the teacher preferred. Two methods have been used in this study to record interviews, tape recording and notes taking based on participants' consents forms.

4.5 Ethical consideration

Before the experiments were conducted and the collection of the data, an ethical review was required to obtain the permission to commence the experiment. This study followed the ethical guidelines provided by the University of Sussex. The pilot study's information sheets (Appendix 2.5, 2.6 and 2.7), recruitment letters (Appendix 2.8 and 2.9), consent forms (Appendix 2.1, 2.2, 2.3, and 2.4), experiment details, interviews questions and surveys were subjected to ethical review.

4.6 Experiment Procedure

This experiment has been approved by University of Sussex Sciences & Technology C-REC ethics board [ER/SA817/1](#) and The ministry of Education planning and development Department in Makkah, Saudi Arabia (see Appendix 1). The heads of the primary schools

approved the application of the study in their schools with the students, and information sheets and consent forms have been given to the students' parents and teachers.

The experiment took a place in the participants' schools during the normal opening hours. Students were asked to complete a short questionnaire individually in their classroom in the Arabic language class before they began the practical group session. The questionnaire has set of pictures that the students need to select the best picture that match their answer as in Figure 4.1. The researcher reads the questions, clarifies unclear questions and answers students questions about the questionnaire. The researcher also ensured that children answer the question before moving to the next question. The questions were about the students use of technology, type of technology they have used, type of activity they do when using technology, reading books or stories at home and whether they enjoying listening to stories read to them to give background on their current use of technology and the way they currently learn (see Appendix 3.1).

 	1. هل تستخدم الاجهزة الالكترونية في المنزل؟
 	2. هل تملك جهاز خاص بك؟
    	3. ماهو نوع الاجهزة الموجودة لديك؟
    	4. ماذا تحب ان تفعل؟
   	5. غالبا، كم عدد مرات استخدامك للجهزة الالكترونية في اليوم (الواحد؟)
 	6. هل يقرأ لك أي احد في المنزل قصص او كتب باللغة العربية؟

Figure 4.1: An example of students questionnaire

The experiment session was performed in a private quite room provided by the heads of schools. All children in the class were divided randomly (apart from the group where they

were selected by the teacher) in to groups of 4-5 students based on the number of the students in the class whose parents had agreed for their participation. Each group attended only one session which lasted approximately 45 minutes which was equal to the time of the formal class. When the teacher selected the students for a group, they came to the room and were provided with the tablets. The researcher explained the application and its functionalities to the participants at the beginning of the session included how to navigate in the app, how to go to the words and sentences pages, how to play the sound of any words or sentences they want, how to create their preferred story at the novice level as well as the expert level and how to share their story to the website. During the session each child worked individually with a tablet. Each group of children has been observed while using the system and the researcher took unstructured notes during the observation process where the researcher captures everything occurring during the session without any predefined categories. The researcher's position in the session was only to show the participants how to use the system at the beginning of the session and during the session with the researcher only providing minimal guidance and assistance.

Following the session the researcher interviewed each group to obtain their perspective on the use of the system and to collect information about student's opinions about using the system such as what they liked, what they did not like, what were the easiest and most difficult parts.

The Arabic language teachers were also interviewed at the school before and after the experiment. At the beginning of teachers interviewing process, the researcher introduced the system and explained the objectives of this study. The main aim of teachers interview was to check and discuss from the teacher point of view if the system is in-line with the curricula and to check what will work best for the students.

Parent questionnaire had been given to the participants' parents via their children in order to examine home literacy environment and the use of technology at their home.

4.7 Results

This section tests the methodology and system functionalities on the three experiments by describing the results of the collected data from observations (students), interviews (both students and teachers) and questionnaire (students and their parents) to answer the research questions.

4.7.1 Pre-Experiment Questionnaire

The results of the pre-experiment survey showed a general and comprehensive background of the students use of technology at home, if they own a device, type of technology used at home, preferred activity while using technology such as listening to songs, watching videos, playing games, reading, drawing or colouring. Moreover, the questionnaire revealed how many times children use technology per day, whether they read stories by themselves or by an adult at home, if so how many times a week, number of books they have at home, whether they liked listening to stories read to them, the preferred way of reading either from tablet or books reading. The results from the questionnaire are described below, which reflect students background mentioned earlier.

Table 4.1 Results for Closed-End Questions for Pre-Experiment Questionnaire for Students

Questionnaire Item	Measure	Percentage
<u>Technology</u>		
The use of technology at home	Yes	96.2%
	No	3.8%
Ownership of a device	Yes	64.2%
	No	35.8%
Type of technology do you have	Mobile phone	47.2%
	Tablet	71.7%
	Laptop	45.3%
	Desktop	11.3%
	Video games	43.4%
Type of activity	Listening	20.8%
	Watching videos	43.4%
	Playing games	35.8%
	Reading	24.5%
	Coloring and drawing	62.3%
Number of times using technology per day	0	0%
	1	28.3%
	2	28.3%
	3	7.5%

	4 or more	35.8%
<u>Reading</u>		
Reading stories at home by children themselves or by an adult	Yes	79.2%
	No	20.8%
Number of times of reading a week	0	18.9%
	1	30.2%
	2	5.7%
	3	17.0%
	4 or more	28.3%
Number of Arabic books at home	0	20.8%
	1	7.5%
	2	13.2%
	3	7.5%
	4 or more	50.9%
Enjoying listening to Arabic stories read to you	Yes	98.1%
	No	1.9%
Preferable reading method	Tablet	60.4%
	Books	43.4%

As can be seen from Table 4.1, 96.2% of the students have access to electronic devices, use technology at home and enjoy using them. This suggests a good level of technological knowledge and experience with regard to interaction with electronic devices and suggests that a tablet-based application should not present any significant issues for the children. Furthermore, 64.2% of the children have their own device and are familiar with using them. According to the type of technology they have at home, the majority of the students (71.7%) have a tablet at home. This is a key finding and supports the choice of development device for this study. Nearly half the students have mobile phones, Laptops and video games with 47.2%, 45.3% and 43.4% respectively. This means that children seem more happy using and have better access to mobile devices rather than desktops. Almost 62% of the students use these technologies for colouring and drawing, 43.4% for watching videos, 35.8% for playing games, 24.5% for reading and 20.8% for listening. Moreover, 35.8% of the students using technology

four times or more per day, 28.3% use technology once or twice a day and 7.5% use it three times a day. In terms of reading at home, 79.2% of the students were reading stories at home by themselves or by an adult, showing good engagement with stories as a learning mechanism. 28.3% of the students were reading or had stories read for them four times or more a week while 30.2% once a week. Almost 51% of the students have four books or more at home. Table 4.1 shows that 98.1% enjoyed listening to Arabic stories read to them and the majority (60.4%) prefer to read from a tablet.

4.7.2 Observation results

Generally speaking, during the observations of the practical sessions, almost all the children were engaged with the learning tool and progressed through the system as intended. The researcher was surprised by the level of competence the pupils exhibited when they created their stories on the application and by how quickly they were able to use it independently. Based on the focus group interview which directly followed the practical session, most of the children mentioned that they had enjoyed using the system, and that they especially liked the pictures, read-aloud feature and creating the story at the novice level. However, some students mentioned issues such as the low sound volume, that creating stories at the expert level was quite difficult and that the system needed to include characters for boys (the system included only female characters as it was initially targeted at girls). When the application was designed, the researcher did not know she would have access to boys. However, Saudi Arabia's new early childhood programme which allowed for boys and girls to be taught together was applied and implemented at the same time as the study. All the issues raised with the system will be addressed in the main study.

4.7.2.1 The first experiment

This experiment took a place at a public female-only school in Makkah, Saudi Arabia. Twenty-five children aged between 7 and 8 participated in this experiment; and were divided randomly into five groups with 5 students in each group. The researcher explained how the application worked at the beginning of the session.

From the observation, it was apparent that almost all the children were excited about using the tablet; and found the application easy to use. When they started to interact with the system, they seemed happy, engaged and more focused. All the children were able to create stories at the novice level and some of them were able to create stories at the expert level and then share their stories. The children who were able to achieve the expert level were able to share their

stories (these are available in Arabic at: <http://www.readingthestory.com/webapp>). Some of children went through the whole process before the session had ended, so they started using the application from the beginning again and went through the words, sentences and created other parts for stories. Some children did not use the sound, while others needed to play the sound in order to hear specific words. Almost all of them knew how to navigate the app, but some did this in an unstructured way and a few did not know where to start. Therefore, the researcher provided some help by reiterating how the application worked and how to navigate through it until every child eventually understood how to use the system.

The children were very happy and smiling when their created stories showed up, and they tried really hard with great concentration to read their stories correctly. They were asking and telling each other about their characters, saying things like: *“My character is Maria, what is your character called?”*.

After the session, when asked about what they liked and disliked about the system, most of the answers were along similar lines, and included positive comments such as: *“I like everything, the sound when it reads the difficult words, this help me to read fast”*; *“I like the sound because it will help me to learn how to read”*; *“The sound will help me to pronounce the word,”*; *“I enjoyed using the app and there is nothing that I dislike”*; *“I like the characters and the activities”*; *“I would like to use this application to help me read difficult and complicated words”*; *“I like the stories”*; *“I like my story”*; *“When the sound is playing I feel very happy”*, *“I like using the system because it helps my mind to grow by learning from reading.”*; *“I like this app because it helps me to learn how to read”*, *“I am very happy to use the system”*, *“I feel that I want to sleep because the story is nice”*; *“I like the pictures as they explain the words and sentences”* and *“This application makes me excited when I read.”* However, one child also commented: *“The part of making stories without questioning [the expert level] is the most difficult part of the application”*.

4.7.2.2 The second experiment

This experiment took place in a public school that applied the new early childhood programme which was implemented in a few schools in Saudi Arabia for the first time in September 2019. This programme mainly aimed at allowing female teachers to educate boys in the first three years of primary education. The classrooms and facilities for the boys are separated from those of the girls; however, the researcher had access to both girls and boys who participated in this study.

In this experiment there were 12 boys aged between 7 and 8 years, who were divided randomly into three groups with 4 students in each group, and 10 girls aged between 7 to 8, who were selected by their teachers as being the five ‘most engaged’ pupils and the five ‘least engaged’ pupils in the class.

4.7.2.2.1 The boys

Based on the researcher’s observation, the boys’ interaction with the application lasted for the entire session. They were very quiet and focused when using the system, and most of them did not speak to each other, especially during the preparation parts. They tried their best to read, and most of them they seemed very happy and amazed when they saw their own stories after the process of selecting and dragging and dropping characters, backgrounds, activities and feelings. After they had created the stories at the novice level, they started interacting with each other and they became very excited to know each other’s characters and when they found out about their peers’ characters they started laughing. They knew how to navigate in the app, and how to move from one page to another but some of them navigated randomly. For example; they jumped from the words page into creating stories at the expert level and they just skipped the sentences pages and created stories at the novice level. They also knew how to play the sound on read-aloud feature and if a boy was seen to struggle his peers tried to explain what to do to him. They liked dragging characters, backgrounds, activities and feelings. Two boys were repeating the words part as they were reading slowly and decoding the words. Although, most boys were able to create the story at the novice level (10 pupils), only 5 were able to create a story and share it at the expert level.

After the session, when asked about what they liked and disliked about the system, many answers were positive, such as: *“I like the application”*; *“I like everything”*; *“I like the words, and sentences”*; *“I like the way that I am able to create my own stories”*; *“I like the sound - it helped me to learn how to read the difficult words and sentences”* and *“I like to read my stories on the tablet”*. However, there was some critical feedback: *“The sound is quite low”*; *“I like the characters but we want more”*; and a few who said *“I do not like the characters because all of them are for girls and there is no character for boys”*.

4.7.2.2.2 The selective girls

The 5 ‘most engaged’ girls read the words, sentences and the created stories easily and quickly during the first 20 minutes of their session. They were very competitive, focused and engaged. All of them were able to create the story at the novice level, and two were able to create the

story at the expert level and share their stories. The rest, who had not been able to share, were nevertheless happy and smiling when they heard and saw their peers' stories on the website. Most of the girls who were able to reach the novice level and /or the expert level started playing again from the beginning as they finished creating their stories in the first 20 minutes of the session.

After the session, when asked about what they liked and disliked about the system. They said *"We like everything"*; *"The words, sentences and the stories were easy to read"*, *"We want difficult and complicated words and long sentences for the stories that we created"*, *"We like the sound as it helps to hear the word if we are not able to read it, but the sound is low"*, and *"I like the pictures because they describe the words"*.

The 5 'least engaged' girls in the selected group were happy and excited to use the system. They used the read-aloud feature while they read. They appeared engaged and tried their best to read and create their own stories and only one was not able to complete the novice level and create her own story; but she was fully engaged and tried very hard to decode words and to be able to read both the words and sentences correctly by mimicking the sounds. The teacher was surprised and impressed by the progress of this group, especially because these girls were disengaged in the classroom.

After the session, when students were asked about what they liked and dislike about the system. They said: *"We like everything"*; *"I like the words part and creating the story"*; *"I wish we could always learn in this way"*; *"The long sentences were quite difficult to read"* and *"Hearing the sound helped us to read the difficult words"*. The girl who was not able to create a story said: *"I like the words and sentences part and the pictures and the sound helped me to read the words"*.

4.7.2.3 The third experiment

This experiment took a place in an international female-only school in Makkah, Saudi Arabia. This school has international streamed programme which offers all subjects in English as well as the Saudi Ministry of Education's Arabic language curriculum. In this experiment, 10 girls aged between 7 and 8 years old participated and were divided randomly into two groups with 5 students in each group.

Based on the observation, the girls from this private school seemed very happy, smiling, excited and engaged but they took a long time and the full session was needed for them to finish the process on the application. This might be due to the fact that their other subjects are taught in

English so they may be less advanced in their Arabic reading. They were concentrating while using the app, reading slowly and decoding for most of the time. They used the sound feature more often than the children from the other schools. They eventually knew how to navigate the app, but some of them started directly from the creation of the stories and some of them did not know where to start. Therefore, the researcher explained to them again how the system worked and how to navigate the app and move from the preparation parts to the creation of the stories. The girls were amazed when they saw their own stories after the process of selecting and dragging and dropping characters, backgrounds, activities and feelings. All of them were able to create stories at the expert level and to share their stories.

After the session, when they were asked about what they liked and dislike about the system, the answers were positive: *“I am very happy to use the system”*; *“I like the words and sentences parts”*; *“I like the pictures”*; *“I like that I created my story by myself”*; *“I like to use the sound to read the difficult words”*; *“The Arabic language is quite difficult and this application makes it easier to learn”*; *“Ah, I wish I could learn Arabic like this”* and *“I feel happy when my friends can hear my voice when I read my story”*. Moreover, they were asking about the application: *“Miss Sara, what is the name of the app, is it on the app store or the Google Play store?”* and *“How can I download it, from where I can get it so I can play with it at home before I go to sleep.”*

4.7.3 Teachers interview

Overall, the teachers were very impressed by the system’s functionalities. They saw a lot of benefits in using the app in learning to read Arabic in early years primary education. They appreciated its potential as an inspiration for teaching reading in an interactive way.

The four teachers were happy and positive about using the tablet and the system in the educational setting especially for teaching reading. Teacher1 said that using a tablet and its applications would encourage children to learn; and that it also helped pupils to read by themselves without the teachers’ help. Teacher 2 mentioned that using the sound would allow students to listen to the words that they could not read or even decode. She added: *“As the application combined between words, sounds and pictures, this will help students to learn many words while they listen, watch and interact with the system, unlike the traditional way of learning”*. Most of the children preferred to play rather than learn and this application helped the student to learn while they play. Teacher 2 ended by saying: *“Please give me the name of the application so I can download it and let my pupils play with it during the reading class*

especially because they seemed very happy when they arrived at the classroom after their session.”

The boys’ teacher commented: *“The boys are very energetic during the class and they are moving all the time, this application would help me to manage the boys in the class by letting them work individually with the application”*. She also mentioned: *“Teaching girls is very different from teaching boys, especially because boys feel bored very quickly when they read or write in the traditional way. However, if I use YouTube to play a video showing a specific story or even children’s songs, they feel excited. This application would help them to learn in an interactive way”*. After finishing the boys’ sessions, their teacher asked me whether she could download this app from applications stores, because she wanted a copy of the app.

During the interview, the teachers were asked to rate the system from 0 to 9, in particular for the extent to which its features encouraged pupils to read and enhanced their skills through the use of storytelling, pictures, the read-aloud feature and sharing stories. Almost all teachers respond positively, and gave the system features a 9 for the following reasons:

“Children like technology rather than books.”

“Children prefer to learn by playing.”

“The use of pictures helps pupils to understand the words”

“Allowing children to create stories by themselves could help with self-expression.”

“Creating stories encourages creativity and imagination in children”

“The use of the sound allows the pupil to correct himself if he reads incorrectly”

“Some students may identify the word from the picture without making an effort to read it but they don’t pronounce the word in formal Arabic, therefore this application will help them to increase the number of words [they know] in formal Arabic”

“The sharing part makes the way of learning fun because when the pupil hears his voice reading while his peers are listening, this will raise his self-confidence.”

Only one teacher rated the sharing feature 8 out of 9 and explained:

“I ranked the sharing features 8 out of 9 because not all children will be able to share their stories”

From the results above, it is clear that the teachers found the system a very helpful tool for their pupils in their learning compared to the formal book.

4.7.4 Parents questionnaire

A survey has been delivered to their parents/ guardians along with the consent and information sheet forms through their children. Parents/ guardians survey had a general information their children such as child reading ability, whether the child has disability, the use of technology at home and if the parents reading stories for their children at home. The survey has questions such as what type of technology your child enjoys using at home, type of technology the child enjoys using by themselves, what do the parents prefer to read stories from: books or tablets/ mobiles and their opinion about using Tablets in children's classrooms for learning Arabic language. The parents were given the survey to obtain a general understanding of the children's use of mobile and electronic devices and how they learn in general prior to using the system

SPSS was used to analyse the data for 35 females and 8 males students, excluding the selective groups (they were not given the survey due to the time constraint as it was the end of the term). It is important to mention that a few students did not bring back their parents' answers.

Based on the parents' answers, no children in this study have learning disabilities. 30 students were at spell letters stage, 12 students were reading fluently and only one student was unable to read.

A 3-point Likert scale (Excellent, Average and Poor) was used, to get children's' ability of using some technology type. The "Do not know" option means the Parent/guardian can not evaluate their child's ability of using the technology while "Does not say" option means the parent/guardian did not tick and option, as in Table 4.2.

Table 4.2: Child ability of using technology

Child ability to use	Laptop or PC	Tablets	Mobile Phone	TV	Video games
does not say	9	2	3	0	14
Excellent	9	35	34	37	8
Average	10	6	4	4	6
Poor	6	0	2	1	6
Do not know	9	0	0	1	9
Total	43	43	43	43	43

Based on Table 4.2, the three technologies that children have the best ability to use were TV, Tablets and mobile phones. 86% of the students have an excellent ability to use TV and almost 81% of the students have excellent ability to use tablets and/or mobile devices. 23 students were using their tablets and/ or mobile devices for more than 24 months, 3 students between 12- 24 months, 4 students between 6-12 months, 1 student less than 6 months and 12 students their parents do not say. 24 students have their own tablet and 1 student owns a mobile phone while the other 18 students do not have their own devices and they share the devices with their household family. 7 students have iPad, 7 students have Huawei, 6 students have Samsung, 1 has a Kindle Fire from Amazon, 1 student has a mobile, 5 did not say the brand name and 16 students share and do not own device. In general, from the 43 children questioned the vast majority had a good level of experience with electronic devices.

A dichotomous scale was used which is a two-point scale (yes, no) to obtain and determine whether the child is enjoying using a specific technology or not as in Table 4.3.

Table 4.3: Type of technology at home that the child enjoy using

Children Enjoy using	Laptop or PC	Tablets	Mobile Phone	TV	Video games
No	34	9	15	13	32
Yes	9	34	28	30	11
Total	43	43	43	43	43

Based on Table 4.3, by selecting cases that either `enjoy_using_tablets` or `enjoy_using_mobiles` variable, SPSS results to 93% of the children (40 students) enjoying either using tablet, mobile or both.

When parents/guardians were asked whether they preferred to read for their child from books or from tablets, 65.1% parents preferred to read stories for their children from books and they mentioned the following reasons:

“Children should get used to read from books from beginning”, “To learn from the beginning the importance of reading from books”, “books are better because it have pictures”, “books are cheaper than tablets/ mobile devices”, “I do not want my child to depend on devices and

delete books from our lives”, “ I want to link between enjoyment and useful information with reading books therefore my child will like reading books in the future”, “ Tablets and mobile devices have many known disadvantages”, “children use tablets and mobile devices for playing and not for reading”, “ I want my child to get some rest and steer clear of using technology”.

23.3% parents preferred to read stories for their children from tablets/mobile devices and they mentioned the following reasons:

“It is easy for navigating between pages”, “Fast and many short stories would be available on which are not available at home”, “The easiness of getting clear stories”, “The easiness of getting stories from websites”, “There are diversity of online stories”, “There are unlimited number of available stories unlike the books”, “ because my child is not able to read books completely”, “ my child prefer seeing pictures and animation”.

4.7% preferred to read from both books and tablets while 7% do not read for their children at all.

When parents/ guardians asked about what your child prefers to use by himself, 58.1% said tablets/mobile devices and they mentioned the following reasons:

“Because the child knows how to use it by himself”, “my child using it the whole time”, “these devices are easy to use”, “for getting attention”, “more enjoyable”, “offers many options”, “ my child is not fully able to read books”, “ some stories has sound”, “Stories have animated pictures”, “Easy to choose a story”, “To increase my child skills”, “The device has an internet”, “Offers diverse stories”, “because children do not care about reading books therefore they use tablets/mobile devices to achieve any goals”, “The child feels free to use the tablet/ mobile devices and does not feel bored”, “because my child enjoy using iPad more than books”.

32.6% said books and they mentioned the following reasons:

“Because my child does not have a device”, “To spend quality time with my child before sleeping”, “Because I do not allow my child to use the iPad more than 30 minutes because of its known disadvantages”, “because my child get use to read stories from the formal study Arabic Language book”, “It has pictures”, “To feel belong with the story”.

9.3% said both and they mentioned the following reasons:

“To increase my child skills”, “To exchange and diversity”.

A 5-point Likert scale (Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree) was used to get parent’s opinion about increasing the use of technology in the classroom to teach reading, using tablets to teach reading, and using tablets in the classroom to teach reading, the answers were combined as Agree (Agree and Strongly Agree) and Disagree (Disagree and Strongly Disagree) as in Table 4.4.

Table 4.4 Results for parent opinion about Technology usage

Item statement	Agree	Neutral	Disagree
increasing the use of technology at the classroom to teach reading	31	9	3
using tablets to teach reading	31	6	6
using tablets in the classroom to teach reading	32	6	5

Table 4.4 showed that most parents agreed with increasing the technology especially tablets usage in the classroom for teaching reading. This is a very positive result as the researcher expected some parental resistance to introducing electronic devices into the classroom.

In general, these results match strongly with those from the student questionnaire and indicate that the children have a good level of experience with mobile devices and they enjoy using mobile devices. Parents seem to be happy with children using those devices, and the majority of them are also happy for them to use them in the classroom for learning. Thus, suggesting that this study is targeting the most enjoyable and well used devices for children.

4.7.5 Differences Between children and parent survey

Both surveys have similar questions in order to obtain information about the students’ background of using technology and the technology usage at home. As can be seen the number of parents who participate in this study were 43 while the number of the students were 57 (before excluding the missing values (4 students) and the selective girls group (10)). To compare the results between the two surveys, the researcher had to remove the children of parents who did not return the survey back to the school (4 students) plus removing the missing values (4 students) and excluding (10 selective girls) which left 39 parents and 39 students.

Table 4.5 Results for the similar questions from both parents and children survey

Questionnaire Item	Measure		Children Percentage	Parents/ Guardian Percentage
Children Ownership of a device	Yes		79.5%	59.0%
	No		20.5%	41.0%
Type of technology do you have at home	Mobile phone		48.7%	89.7%
	Tablet		71.8%	82.1%
	Laptop or Desktop		51.3%	59%
	Video games		33.3%	46.2%
Number of times using technology per day (Children survey)	0		0%	
	1		25.6%	
	2		25.6%	
	3		2.6%	
	4 or more		46.2%	
My child's time spent on using technology per day	Desktop/ Laptop	Does not use		76.9%
		Less than half an hour		12.8%
		Between half an hour to one hour		10.3%
		Between 1 to 2 hours		0%
		More than 3 hours		0%
	Tablet	Does not use		23.1%
		Less than half an hour		20.5%
		Between half an hour to one hour		30.8%
		Between 1 to 2 hours		10.3%
		More than 3 hours		15.4%
	Mobile phone	Does not use		38.5%
		Less than half an hour		20.5%
		Between half an hour to one hour		23.1%
		Between 1 to 2 hours		12.8%

		More than 3 hours		5.1%
	TV	Does not use		2.6%
		Less than half an hour		25.6%
		Between half an hour to one hour		33.3%
		Between 1 to 2 hours		33.3%
		More than 3 hours		5.1%
	Video games	Does not use		64.1%
		Less than half an hour		12.8%
		Between half an hour to one hour		12.8%
		Between 1 to 2 hours		7.7%
		More than 3 hours		2.6%
Reading stories at home by children themselves or by an adult	Yes		74.4%	92.3%
	No		25.6%	7.7%
Number of times of reading a week (Children surveys)	0		23.1%	
	1		23.1%	
	2		7.7%	
	3		15.4%	
	4 or more		30.8%	
Everyday, I read for my child (Parent surveys)	I do not read			7.7%
	Less than half an hour			69.2%
	Between half an hour to one hour			17.9%
	More than one hour			5.1%
Children Preferable reading method	Tablet		56.4%	30.8%
	Books		48.7%	61.5%
				Both (7.7%)

Table 4.5 shows that 79.5% of the children say they own a device while 59.0% of the parents/ Guardian say that their child owns a device. The most likely reason is that children do not

distinguish between whether a device that they use is owned by them or owned by their parents. The most ownable technology at home are mobile phones and Tablets with 89.7% and 82.1% respectively based on the parents/Guardian point of view. From children point of view, Tablets and Laptops/Desktop are the most ownable devices at home with 51.3% and 71.8%. As can be seen Table 4.5 shows that the majority of the children are reading stories by themselves or by an adult at their home. 61.5% of the parents/ Guardian believe that the children preferable reading method is books while more than half of the children say that they prefer reading from tablets.

4.8 Discussion of the Pilot Study Results

The pilot study was conducted to examine the methodology and process of capturing results and feedback. The pilot study also tested the system's functionality and usability; and identified some small interface issues which were addressed in the main study. There were no other issues with functionality.

The pilot study demonstrated that children were able to use the system without difficulty, and the experiment was effective in obtaining the data required. The analysis of the data clearly indicated that the proposed system enhanced pupils' engagement and had a potential to improve their reading abilities. The system not only helped the children to read, it also enabled them to create their own stories and then share them with their peers. This sharing can improve their self-esteem, which in turn gives them the opportunity to develop their critical skills, creativity and imagination.

The system also provided different levels of flexibility and difficulty which allowed the children to learn at their individual pace. It provided several means of representing the knowledge in different forms such as texts, pictures and sounds, and gave different forms of feedback when the child interacted with the system or achieved a specific level by use of images, text and sound. In summary, the combination of the use of storytelling and UDL in the mobile learning application tested here showed a high probability of enhancing engagement and positively affecting reading ability.

4.8.1 Student Engagement

From the observation process explained in Section 4.7.2, almost all the children were excited to use the tablet, and when they started interacting with the system, they seemed happy, engaged and more focused. They were very happy and smiling when their created story showed up on the system; and they tried really hard to read their stories correctly. They were asking

and telling each other about their characters, with comments such as: “*My character is Maria, what is your character called?*”. Therefore, these results clearly indicate increased student engagement and that the proposed system enhances engagement and has the potential to improve reading ability.

4.8.2 System Functionality and Usability

As aforementioned in sections 4.7.2 and 4.7.3, from the observation process, and feedback from children and teachers, the system is promising, easy to use and children can use it independently. It is a potential tool for teaching reading in an interactive way, as opposed to just reading a book, and it helps students to read independently. It also allows children to learn while they play; and enabling them to create stories by themselves could help them develop their expression, creativity and imagination. The teachers mentioned that sharing stories created by the students made learning more fun, because when the pupils heard their voices reading while their peers were listening it would raise their self-confidence.

The teachers were asked to rate the system functionalities from 0 to 9. Almost all the teachers responded positively, rating the system’s features as 9, except one teacher who rated the sharing feature 8 out of 9, and explained that not all children would be able to share their stories.

Additionally, after completing the experiment, the children were asked for their opinions about what they liked or did not like about each part of the system. From their answers most of them seemed to like everything on the app. A few students mentioned that the sound volume was rather low, that they wanted boy characters and that creating stories at the expert level was quite difficult, as there were no questions to help them to create stories.

4.8.3 Pilot Study Challenges

Accessing schools in Saudi Arabia is quite hard and it required a long and complicated process to get permission to gain access. There was also the challenge of audio-recording during the interviews, in order to collect the data for the study. Some teachers preferred not to record their own voices; therefore, the researcher was required to take down notes, which has some disadvantages such as causing interruptions and reducing the flow of the interview.

4.8.4 Limitations and Future Work Demonstrated by the Pilot Study

The pilot study generally showed that the system was operating correctly, and valuable results were obtained from the proposed methodology. Although a positive effect on student engagement was indicated by the pilot study, there was no evidence of the system’s effectiveness in enhancing the learning of reading Arabic. Therefore, pre- and post-test should

be implemented in the main study to enable the measuring of the proposed system's effectiveness in enhancing reading ability, fluency and comprehension. Moreover, a comparison between the control group and experimental group could be completed to measure the system's effectiveness. Furthermore, the pilot study samples (57 pupils, 43 parents and 4 teachers) were relatively small, which made the results statistically limited.

Additional limitations were related to the pilot study being conducted at the end of term, when the teachers had already finished teaching the curriculum. Thus, some pupils did not return their parents' answers to the survey, and there was a lack of time for interviewing the teachers because they had to mark assessments. This situation was due to delays in obtaining the Ministry of Education's approval and the ethical review approval.

The results obtained also indicated that a slight modification was needed in the methodology. Although the children's survey contained pictures to help them answer the questions read out by the researcher who tried to clarify any words that seemed unclear, the researcher cannot guarantee the children's understanding of the words. This problem could be overcome either by clarifying some questions to be even more clear and specific to avoid children's confusion when they are answering, or by asking the parents about their children's background rather than asking the children themselves. As there was a difference between the answers provided by the children and by their parents about the general background of the children, their use of technology at home and their home literacy environment, it was decided to get this information from the parents rather than from the children, in order to get more reliable information.

Finally, based on the pilot study results and the feedback retrieved from both the teachers and the pupils, the system requires modification as follows:

- Replace the NEXT button with an arrow.
- Add more words and sentences.
- Add boys' characters.
- Make the story sentences a bit longer.
- Make the sound clearer and louder.
- Bigger sizes for text and images.
- Guide the students during the app (to solve the problem of randomness when they use the app).

All these limitations and modifications will be considered for the main study.

4.9 Summary

This chapter demonstrated the implementation and the results of the pilot study. The pilot study mainly was aimed to test the effectiveness of the experimental methodology and the system functionalities. The experiment ran successfully, the students were able to use the system and the results were obtained and gathered.

Based on the pilot study findings, the experimental methodology needed to be refined for the main study by overcoming the identified issues in this study. Additionally, the students' and their teachers' feedback was taken into consideration in the development of the novel mobile application before conducting the main study.

Chapter 5: Full study

5.1 Introduction

The full study is the main experiment that was carried out for this research to answer the research questions and examine the research hypothesis (in section 1.6) and research contributions outlined (in section 1.7). There were some modifications and changes on the experimental procedures and the developed system that were made prior to conducting the full study. These changes were based on the pilot study results and as a result of the Covid-19 restrictions.

5.2 System Architecture

The system architecture of the full study was similar to the pilot study as discussed in section 3.2. Changes were made based on the feedback of the pilot study. Here, a database was added to the system architecture as shown in Figure 5.1 to store and retrieve the students' comments from and to the website as in Figure 5.2.

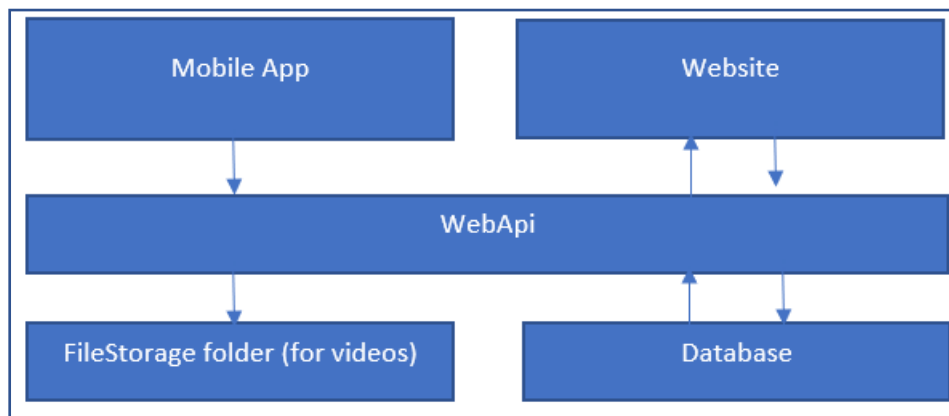


Figure 5.1: System architecture of the full study with the database added.

This allowed the students to write comments on each other's stories and retrieve the comments made by other students as in Figure 5.2.



Figure 5.2: The website where students can see each other videos, comments on each other videos and read the comments.

Additionally, there were some changes to the interfaces of the developed mobile application based on the researcher observations, student and their teacher feedback from the pilot study such as restricting the students from navigating randomly through the application i.e. they need to finish the word level before going to the sentences as in Figure 5.3, increasing the size of the text as in Figure 5.4, replacing the NEXT button with an arrow as in Figure 5.5 and adding characters for boys as in Figure 5.6.

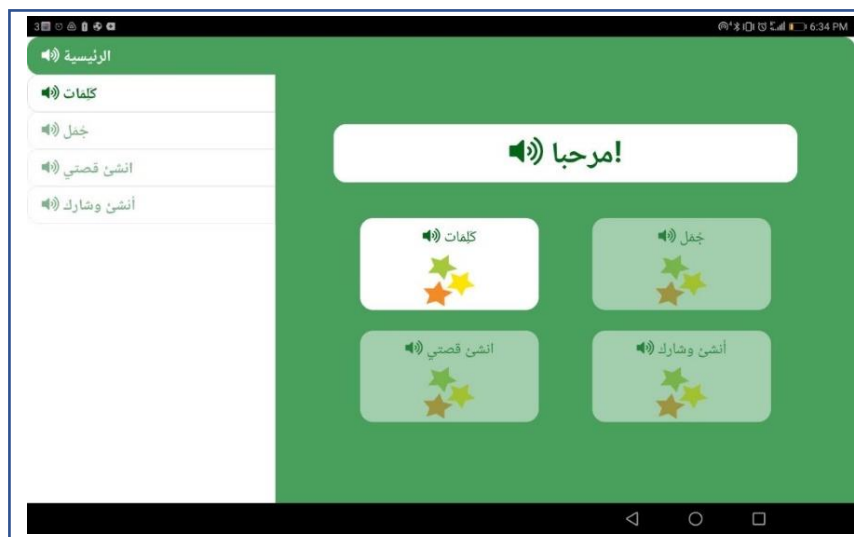


Figure 5.3: The main page where students were restricted from navigating randomly through the application

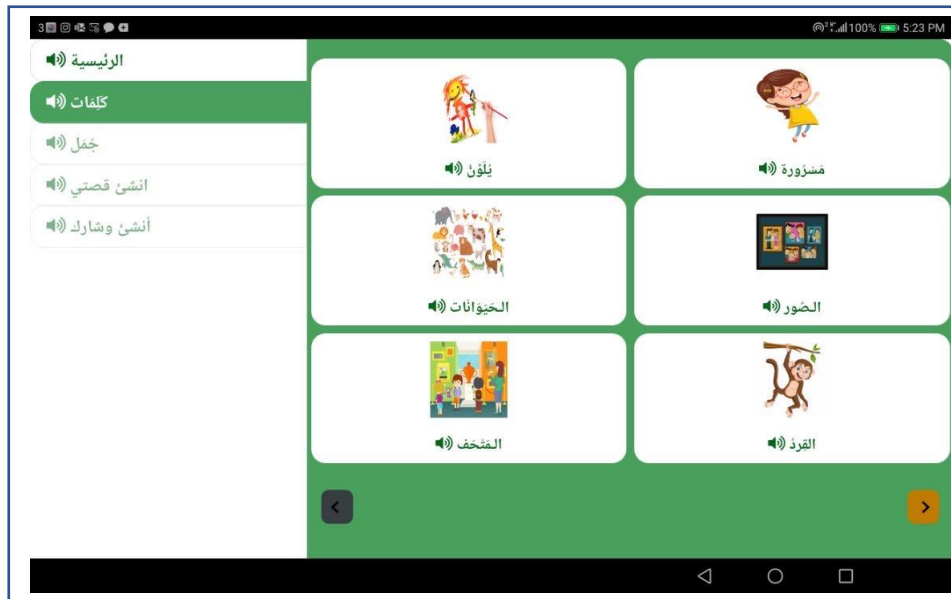


Figure 5.4: increasing the size of the texts



Figure 5.5: replacing the NEXT button with an arrow

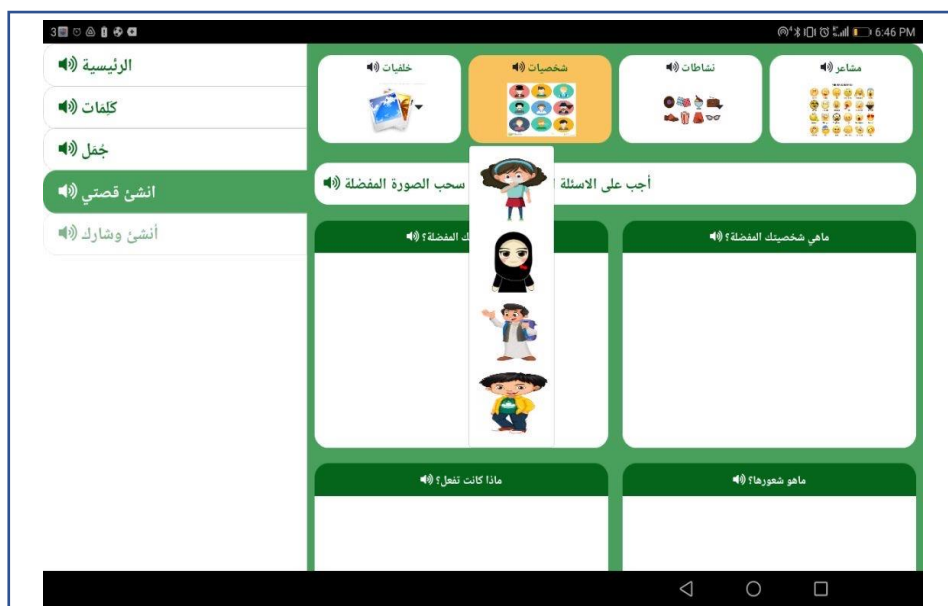


Figure 5.6: adding characters for boys.

5.3 Methodology

5.3.1 Covid-19 pandemic and its main effect on the study methodology

Due to the novel pandemic Covid-19, the methodology has been changed. It was originally planned to run this main study using the same in-person method as the pilot study. However, accessing students in their classes and in-person observation was not possible due to the school closure during the pandemic and therefore the study has been modified to allow it to be run virtually. Moreover, the pandemic has significantly restricted the researcher access to the students so although it was envisaged that this study would be run with potentially 100 students factors only allowed the researcher to run it with 40 students (experimental group=25, the control group=15).

5.3.2 Planned Methodology before Covid-19

This research used a mixed methods approach where both qualitative and quantitative approaches were used to answer the research questions. The qualitative approach was based on the semi structured interviews of the teachers, observation of the students while they interact with the designed system. The quantitative approach was based on pre/post test for students and surveys for both the students and their parents. The research was planned to take place in schools during the term.

All students in the class will be tested individually before they begin the practical group sessions, which will be with the intervention for the experimental group (i.e. using the

developed mobile learning application) and with no intervention (i.e. using the traditional learning methods) for the control group, and after to evaluate their reading fluency and comprehension abilities. Each test will be one story (passage) which contains 70 words each one is expected to be read for 3 minutes approximately. The stories (passages) will be a similar to the stories in the formal text book. As students read the passage, the researcher will sit at a comfortable distance from the participant and will note the errors on a separate copy of the passage and will mark where the student was at the end of one minute, and also will record the time it took for reading the entire passage. Immediately following the oral reading test, the passage will be removed and students will be asked to respond orally to five questions from the passages. The researcher will read each question. Questions forms include who, what, when, where, why, or how questions. All students will learn the same materials but different methods of learning. For the practical sessions, all children in the class will be divided randomly in two groups; control group who will receive no intervention and experimental group who will receive the intervention. The experimental group will be divided randomly into groups of 5 students. Each group of students will attend three sessions distributed into 3 days (i.e. one session per day), each session should last approximately 45 minutes which is equal to the class time. The three sessions will give the researcher a good coverage of the students progression with the system from initial novice user to expert over the three sessions. In each group session, each child will work individually with a tablet. The system will be accessible via the tablet and enables children to create their own stories by interaction with pictures, words and audio to enable the building and sharing of stories. Each group of children will be observed while using and interacting with the system and the researcher will take written notes during the observation process. Following the three practical sessions, all children will then complete a short questionnaire individually within these group at the school to obtain their perspective on the use of the system. The Arabic language teachers will also be interviewed at the school before and after the experiment. A short questionnaire will be sent to the parents/guardians to provide background information relevant to the home literacy environment and the use of technology at home. After the experiment, the system will be given to the teacher and become available to all students in the class.

This experiment has been approved by University of Sussex Sciences & Technology Cross-Schools Research Ethics Committee (SCITEC) the approval number - ER/SA817/3 and The ministry of Education planning and development Department in Makkah, Saudi Arabia.

5.3.3 Methodology of the main study during Covid-19

As stated above Covid-19 lead to school closures and moving to online classes which has affected the methodology of the main study. Therefore, the researcher had to change the methodology based on the situation of Covid-19 restrictions. The overall methodology is the same as that outlined above, but with the following modifications. All in-person interactions were moved online, thus the study instruction and observation was implemented via Microsoft Teams with online semi structured interviews of the teachers (appendix 5.3), online video observation of the students while they interact with the designed system (where the researcher took unstructured notes, appendix 5.6), online pre/post test for students (appendix 5.1 and 5.2) and online surveys for both the students (appendix 5.5) and their parents (appendix 5.4).

The main study comprises two experiments completed in October 2020 and organized in two different schools. The first experiment was in a public primary school for girls only while the second experiment was in public school that applies The Early Childhood Schools Project in Makkah, Saudi Arabia where both boys and girls are assigned to female teachers as explained in Chapter 4 (section 4.3).

Three classes participated within a period of 7 weeks and with 40 students. The participants in these experiments were students who their parents agreed and signed consent for their children's participation.

This main study as a whole uses a small sample size with different groups of students from multiple schools to measure the effectiveness of this system in enhancing students reading fluently and comprehension and to examine student engagement and satisfaction when they interact with the system. Additionally, the study checks that the system is in-line with the curricula and identifies what will work best for the students and their needs from a teacher's perspective, to gain a general knowledge of children background of using technology and the way of reading at home from their parent point of view.

5.3.3.1 Sampling participants

Participants of the full study were recruited based on a convenience sampling strategy which is considered as a type of nonprobability (non-random sampling) where participants are willing to participate according to their availability and convenience (Etikan et al, 2016: Cohen et al, 2018).

The participants were second year primary school children aged between 7- 9 years old (male=13 , female=27) (25 experimental group, 15 control group), their parents and three Arabic language female teachers in the fall term (first semester) of academic year 2020-2021 in two public school in Makkah city in Saudi Arabia. There was a student who had been observed during the three practical sessions, participated in the surveys, but could not read the pre/post tests as he does not know the letters of the Arabic language. Therefore, this student was excluded from the sample.

The students who participated in this study did so with their parents/guardians signed consent and agreement for their children's participations.

5.3.3.2 Instrument translation, Validity and Reliability

Arabic language is the main language of Saudi Arabia. Therefore, surveys and interview questions have been translated by the researcher into the Arabic language. The Arabic versions have also been translated back into English by the researcher and checked by an interpreter who is a PhD colleague who studied linguistics at the University of Sussex.

Based on Yaghmaei (2003) content validity refers to “the degree that the instrument covers the content that it is supposed to measure”. Content validity was conducted for study instruments; surveys and interviews. The tools were given to three experts in Saudi Arabia. They read the instruments in both Arabic and English languages, they also read the aims and objectives of the study. They confirmed the validity of the study, but suggested some points to be changed for improved comprehension of the questions. Therefore, the researcher changed these tools based on the given feedback.

Internal consistency used to measure the consistency between different items of the same concept and construct (Tavakol and Dennick, 2011). Here, internal reliability of students survey was examined for system usability and user satisfaction. For measuring the internal consistency of the students surveys, Cronbach alpha (Tavakol and Dennick, 2011) was used to measure the internal consistency of system usability and user satisfaction scales. Cronbach's alpha coefficient showed good reliability for system usability (Alpha=0.79), and a similar good reliability score for user satisfaction (Alpha=0.70).

5.3.3.3 Data collection method

This study used online video observation via Microsoft Teams while the researcher took unstructured notes to observe students while they interact with the designed system. It also used semi-structured interviews with the teachers before and after the experiment to obtain

general understanding of the use of technology in the classroom, the way of teaching Arabic language and the use of storytelling during the lessons as well as to check that the system is inline with students' needs and level. Also, to collect information about the system usability by evaluating the system effectiveness and its suitability for the children as well as validity of the experimental methodology. The teacher interviews were scheduled in advance at a designated time, one teacher preferred to perform the meeting during the school's opening hours and location inside the school, while the other two teachers preferred to perform the meeting after school hours and online through Microsoft teams. The interviews questions were constructed based on the literature and inline with the research objectives.

The study also used questionnaires for both students and their parents. Students survey aimed at obtaining students' feedback about the system usability and their satisfaction about using the system by asking them to respond to 31 statements by assigning a score on 5-point Likert scale with smiley faces ranging from very sad to very happy. Also, they responded to open ended questions.

Parents survey aimed to obtain a general knowledge about students background of using technology and the way of reading at home.

Pre/ post test were used to evaluate the system effectiveness on enhancing students reading fluency and comprehension. The main second year learning objective is that the students are able to read texts 70-80 words in length. The students will be tested individually before and after the intervention to evaluate their reading fluency and comprehension abilities. Each test will be one story (passage). These tests were obtained from the formal learning book with slight change in the length. The pretest was obtained from the previous year formal book. It was about 40 words and therefore the researcher increased the number of words to 71 words which is considered as the aim of the second year students to be able to read. The post test was taken from the formal book of the current year (year 2). The text length was approximately 128 words therefore the researcher reduced the number of the words to be 72 words. After preparing the two texts with approximately 70 words in each, the teachers have been consulted to check if the modified versions of the pre and post test are suitable for the second year primary students. As students read the passage, the researcher noted the errors and marked where the student was at the end of one minute, and also recorded the time to read the entire passage. Immediately following the oral reading test, students were asked to respond orally to five questions associated with the reading passage. The researcher read each question. Students receive a 0

for an incorrect response or no answer, a 1 for a partially correct response, a 2 for each correct answer.

Questions forms differ between the two tests, but include who, what, where, why, and how questions.

5.3.3.4 Dependent and Independent Variables

To measure the pre/post test and confirm the hypothesis of this study explained in Chapter1 (section 1.6), there are independent and dependent variables:

The independent variables were the manipulated variables by the researcher:

- 1- Group type variable: where the participants participated in either the experimental group (each student interacted with the system in three sessions) or the control group (which uses standard learning via the School through the virtual classes - Madrasti platform). This is considered as between groups (Experimental vs control).
- 2- Time variable: which uses repeated measure design (pre- test and post-test).

Dependent variables are the variables that the researcher measures during the experiments and could be affected by the independent variables.

- 1- Total reading time in seconds: This refers to the total time students spent to read each test.
- 2- Rate at 1 minute and 3 minutes: This refers to the number of words students read per minute. The rate was calculated at 1 minute and 3 minutes.
- 3- Word correct per minute - WCPM at 1 minute and 3 minutes: This refers to the number of words read correctly by the students at 1 minute and 3 minutes.
- 4- Accuracy at 1 minute and 3 minutes: Accuracy was calculated as the percentage by dividing the number of words read correctly per minute (WCPM) by the total number of words read per minute. The accuracy was calculated at 1 minute and 3 minutes.
- 5- Comprehension (Total right answers, Total wrong answers, Total half answers): Here, students answered orally five questions associated with the reading passage. They receive a 0 for an incorrect response or no answer, a 1 for a partially correct response i.e. if incorrect information was included along with the correct response, a 2 for each correct answer.
- 6- Total right words/ wrong words per test: Here, the total number of right words and total wrong words read by students on the both pre and post tests were measured.

5.3.3.5 Experiment setting during Covid-19

This modified experiment has been approved by University of Sussex Sciences & Technology Cross-Schools Research Ethics Committee (SCITEC) the approval number - ER/SA817/4 and The ministry of Education planning and development Department in Makkah, Saudi Arabia. The heads of schools approved the study with their schools' teachers, students and their parents. The experiment took place online.

First, the researcher obtained the Head school teachers consent and approval for doing the study and collecting the data of the two schools during the opening time of the school. The head teachers provided the researcher with the schedule of the Arabic language teachers and when they will be attending the school (please see the Covid-19 pandemic and its effect on the Saudi educational system section above). The researcher met the school teachers at school during the opening hours and explained the study and answered their questions. The consent forms, information sheet and recruitment letter were given to them at this point. Initially six teachers had agreed to participate, but because the researcher was unsuccessful in finding participants who agreed to participate from three classes, the associated 3 teachers were removed from the study. The main aim of teacher interviews were to obtain general information about using technology and storytelling in the class and the way the Arabic language module was taught. Moreover to check and discuss from the teacher point of view if the system is in-line with the curricula and to check what will work the best for the students.

The parent consent forms, information sheet, recruitment letter and survey were sent to the teachers email so they can forward them to their student's parents. The parents who are willing for their children to participate, contacted the researcher to provide their home address and determine the most convenient time for them in order to deliver the tablets. Tablet specifications were the same as those detailed in Chapter 3 (section 3.4).

The main aim of parent questionnaire is to examine the home literacy environment and the use of technology at their home. The estimated time to complete the parent survey is 9 minutes based on the Qualtrics only survey.

As the observation process is online, it requires high speed internet connection and a camera. Therefore, the researcher delivered 2 tablets. One tablet contains the novel designed application with the sim card that has high speed internet connection and the second tablet which is linked to the internet of the other tablet and contains Microsoft teams with a new email that the researcher created especially for the study. The parent is trained by the researcher on

how they open the app and Microsoft teams. By doing so, the researcher has overcome problems related to participants not having internet access or having slow internet connection, and issues with users not having a Microsoft teams account or not knowing how to use Microsoft teams. In order to observe the participant, the researcher linked her Microsoft teams with the second tablet that has Microsoft teams and asked the parents to hold the second tablet (as Camera) while their child plays with the tablet that has the application.

As each child in the experimental group must play with the app for three sessions and each session will last for 45 minutes. The researcher noticed that it was difficult for the parent to hold the tablet for 45 minutes so the researcher bought a tablet holder and asked the parent to put it in a good position in the room so the researcher can see the child and the application while the child plays with. Sometimes the researcher asked the mothers to move the holder and the tablet to observe the child's face or the application as sometimes children change their posture and the way they sit during the session.

Once all the settings were working and in place, the researcher asked the children for their consent before starting the first session.

If they agreed to participate, and before doing the observation the researcher shared the pre test to the second tablet through Microsoft teams and then asked the children to read it aloud and answer the comprehension questions. Then the researcher started observing them. After doing the observation, the researcher shared the post test and asked the child to read it aloud and answer the comprehension questions.

As students read the passage, the researcher noted the errors and marked where the student was at the end of one minute, and also recorded the time they took reading the entire passage. Immediately following the oral reading test, the students were asked to respond orally to five questions from the passages.

Once the session was finished, the researcher came back to the parent's home to collect the devices in order to deliver them to the next participant's home. Before delivering the devices to the participants homes the researcher sanitized all devices. The completion of this study required 8-10 hours every day for delivering the devices, running the study, completing the observations, collecting devices, with some participants located over 50 minutes away from the previous participant.

5.4 Results

5.4.1 Researcher observations made during the three sessions

The researcher made online observations of 25 pupils (6 boys and 19 girls) from two different schools through Microsoft Teams. Each child was observed for three sessions. One boy was removed from the sample as he did not know the letters, therefore could not read the pre- and post-tests although the researcher had completed the three sessions of observation with him. This boy had progressed very well with the help of the pictures and read aloud features and tried to mimic the sounds that he heard.

After delivering the tablet and doing the pre-test, the first practical session was started immediately after this. Mothers sat next to their children and moved the camera as the researcher requested. The researcher explained how the application worked through Microsoft Teams.

5.4.1.1 The first session

In the first sessions the researcher noticed that the children quickly became independent when using the application, they used it easily moving from one page to another without difficulty. One mother expressed surprise and told me that her daughter did not have a tablet at home and that she was impressed with how her daughter had interacted with the application so independently and easily.

One child had poor eyesight so the researcher had to increase the size of the text and pictures on the application so this pupil could read the text in the app.

All the children were focused while using the application. One boy's mother said: *"I feel my son is focusing and this is so exciting, because he usually wants to avoid Arabic lessons and cries about doing this subject because he does not like reading"*. There was also a participant whose sister (a third year aged ten) and was sitting next to her and both were completely focused and quiet.

The children were smiling during their use of the application when reading the words and sentences through to selecting new elements for their stories. Generally, they all seemed happy when their created story appeared and when they read their stories. This behaviour indicated that they liked interacting and using the application. A few actually spoke aloud while using the app and said "Yes", "Yay" or "Congratulations" when they saw the feedback page which displays the word 'excellent' when they finished the words and sentences levels. One pupil

said “*I like reading from this application*”; and another said: “*Now, I will create my own story*” when he had finished the words and sentences level.

A few children pressed the word/sentence container that included the word or sentence along with the picture and read-aloud function. By doing this the colour of the pressed container changes to orange so the learners can see where they are and what they are currently reading.

Almost all the children tried their best to read correctly, especially when they read their stories although they were spelling and decoding words. Three girls and one boy were very non-fluent readers and they were decoding slowly, but the pictures and read-aloud feature helped them to progress within the app. They tried to mimic the sounds and read after the sounds. By doing so along with the help of pictures, they finished the word level and had done half the sentences level by the end of the session.

Pictures helped the children to identify the word or the sentence they were reading. Two children used the word ‘*Albar*’ when they saw the picture of the desert which is the informal word for ‘desert’ while the formal word is ‘*Alsahraa*’.

Seventeen children used the read-aloud feature to hear the word, sentence or the story. However, some of them they only used the read-aloud features if they were having difficulties in reading or pronouncing the words and/or sentences.

More than half of the children were able to create their own stories at the novice level. The researcher noticed that some tried to select more than one character, but they could not as the system will display an error message if this happens. Although the application is guiding the children, and no one can go to the next level until they have finished the current one, two children were trying to go directly to creating stories at the novice level but they were unable to do this as the application prevented them. Moreover, most of the children read their stories in the first version i.e., the story with pictures, and they skipped the final version of the story which did not have any pictures i.e., abstract texts.

There were a few who were able to share their stories and were so excited when they knew that their friends, families and their teachers would see and listen to their stories. One of them said “*Yes!*” as a sign of excitement. Also, some of them were reading quietly and their voices were low, but when they knew that their reading would be recorded, they tried to raise the voices.

One girl who finished sharing her story, then went back again to the sentences level, created a different story at the novice level and then created a different story at the expert level and

shared her new story. This time she read her story in a loud voice, because when she listened to her previous story, she realized that her volume was too low. She also was able to create and share a new story for the third time, saying that she liked reading from the app. This girl was really engaged with the application and wanted to use it again.

Another girl also changed her voice and tone while reading her stories, and after sharing her story, she went back again to the sentences and created another story at the novice level. While doing this, she was thinking aloud, saying: *“What character should I choose, this one or that? The first time I selected that one, now I will select this one.”* Another girl also thought aloud while selecting the elements for her story at novice level, naming them as follows: *“This is the camera, this is the happy face”* and so on.

By the end of the first session, seven children had fully progressed through the app and were able to create and share their own stories at the expert level; Sixteen children were able to create their own stories at the novice level but three of them did not read the full story. One child was unable to finish the word level, and seven children, one of whom had a learning difficulty, were unable to finish the sentences level. One child was only able to finish the word and sentences by the end of the session. Also, almost all boys selected the male characters and all the girls selected female characters.

5.4.1.2 The second session

Most of the children knew how to use and navigate through the application. One mother tried to help her daughter to use the application even though her daughter was good at it, but her daughter protested saying: *“No, no mama I can do it by myself”* and she started explaining to her mother how she was creating her stories saying: *“When I drag and drop the wrong pictures in the wrong place, an error will be displayed on the screen”*.

The children were eager to start playing and reading. They were focused and smiling when reading the words and sentences and creating and reading their stories. They generally interacted with the system independently and almost all of them they did not look away from the screen. When one girl finished the word level she exclaimed *“Trrrrraaaaa!”*; when another had finished the words and sentences level she said: *“Now, I will create my own story”*.

The children made significantly more progress through the application than in the first session. They tried their best to read even though some of them were decoding. They were reading the words and sentences faster and louder than in the first session. The two pupils who had used

an informal word for ‘desert’ in the first session, used the formal word and pronounced it correctly in this session.

The pictures and read-aloud features were helpful to the children while reading. Some used the read-aloud feature a lot, while others only used it if they had difficulties and with long sentences. Two pupils made use of the word/sentence container to identify where they were and what they were reading currently.

The children knew how to use the app to create their stories at both levels. Five of them said that they wanted to download the application on their own devices to play, read and learn at home.

Some children listened to the sentences without reading them. One girl had some difficulty in reading sentences that consisted of three words or more and just listened to them without reading them, especially because in the first session she was not be able to finish the sentences level, although she seemed in a hurry and excited about creating her story, which she was eventually able to do. While she was creating, she changed and deleted elements that she already selected because she was thinking about her story. When her story appeared, the words of the story seemed long to her because of her difficulty in reading. Another girl skipped sentences that consisted of five words and just listened to them; she was able to create her story, but did not have time to read it. One boy exhibited difficulty in reading the sentences of four words or more; however, he was able to create his story and read half of it.

In the second session, the boy who had difficulty in recognizing letters was able to finish the word and sentences level by looking at the pictures and listening to the read-aloud feature and mimicking the sound. He was excited about creating his own story and he was able to do that at the novice level. He was thinking out loud while selecting the elements for the story, saying: *“I will choose this. No, no I will choose that”*. He smiled when his story appeared but unfortunately was unable to read it; however, he listened to his story through the read-aloud feature.

The pupil who had only been able to finish the word level by the end of the first session, was faster in the second session and reached halfway in the sentences level. Another girl who got halfway through the sentences level in session 1 was much faster in the second session. She finished the words and sentences levels although she had to read letter by letter to be able to pronounce entire words. She was very focused and trying really hard. She also was able to

create her story, and seemed happy and smiling. She was able to read the first part of her story (the character section).

A few students were thinking aloud while creating their stories *“What character should I choose? What background?”*; *“I will choose this”*; *“This is a happy face”*; *“Will I choose drawing or taking pictures, happy or sad”*. Most of the students were able to create the story at the novice level. One girl created her story and read it at novice level, then, although she was able to proceed to the expert level, she recreated her story at the novice level.

A few of the children were able to create the story at the expert level. One girl finished sharing and reading her story, then went back to the novice level and tried new elements of the story and different ones from the previous stories. Another girl shared her story and listened to it on the website, then criticized her performance saying: *“I cannot hear my story, my voice is too quiet”* Consequently she tried to speak up when she created and shared another story. After that she went to the novice level and selected different elements, and when she selected ‘angry feeling’ she laughed. Her mother told me that her daughter wanted to have a copy of the application on her device.

Another student, created her story and shared her story twice. One girl who shared her story and listened to it on the website became extremely excited when she knew that she could comment on her friends’ stories and they could comment on hers. She said: *“If I saw my friends were unable to read some words, I could help them and encourage them”*. When she finished listening to her shared story, she went back again to the sentences level. Many of the children seemed keen to have their stories read and were interested in their friends’ stories. One girl said: *“I wanted my friend to read my story”*; another changed her tone while reading her story; another tried to read her friend’s story aloud when she listened to it. One girl shared her first story and then listened to herself and realized that her voice was quiet, therefore, she created and shared another one, which she read as loudly and as accurately as possible. Another girl who was able to share her story in the first and second sessions told me: *“Today I was able to read fast with my teacher, I feel it’s because of the application as I played with it yesterday”*.

However, there were some examples of pupils struggling at expert level. One girl created a story at the expert level but she did not read it; instead, she went back to the novice level and she created her story there and read it. Another girl shared her story but her reading was not fluent and it contained lots of mistakes. One boy was able to create the story at this level but because he took a long time and it was the end of the session, he was unable to read it.

The ability to share the story, comment and get comments from others encouraged the children to read loudly and correctly, although most of those able to read their stories, read the first version (the story with pictures). All the girls selected female characters, and all the boys except one selected male characters. One child appeared to be using the device sometimes horizontally and sometimes vertically.

By the end of the second session, all the children had finished the word level; one was unable to finish the sentences level, however, she had only finished the word level in the first session. Twenty-four pupils were able to create their own stories at novice level but eight of these did not read the full story as they were decoding. Ten pupils fully engaged with the application and were able to create and share their own stories at expert level.

5.4.1.3 Third session

As in the previous sessions, the application appeared easy to use, and the children used it without any difficulties. They also liked it and enjoyed using it, playing with it very independently without asking any questions. With the help of the pictures and the read-aloud feature, they progressed very well; and read quite fast and more accurately than in the previous sessions. Some children talked to themselves while playing, and some of them were thinking aloud when selecting the elements for their stories. They read loudly, and appeared confident when they read the texts.

The children who were fluent in their reading finished using the application and shared their stories very quickly before the session ended, and then went back to the words and sentences level or created new stories. Those who were decoding words had improved their reading in comparison with the previous sessions. For instance, the pupil with learning difficulties was reading a bit better than in the first two sessions, while the boy who did not know letters was using the read-aloud features and the pictures to help him read the text.

The pictures helped the children to read the texts; and the read-aloud features allowed them to read the difficult texts and then mimic the sounds they were hearing. The children created their stories easily and some of them were selecting and changing the elements for their stories. However, a few pupils who reached the expert level forgot to press the share button.

By the end of this session, all the pupils had finished the word level and the sentence levels; and only one pupil was unable to create her story as she just finished the word and sentences level by the end of the session; Twenty-four pupils were able to create their own stories at the

novice level but five of them did not read the full story as they were decoding. Eleven pupils were able to create and share their own stories at the expert level.

5.4.1.4 General notes

Some children read the words correctly when using the application but made mistakes in the post-test, which was after the third session. These errors could be because the pupils did not have the stimulus of pictures and sounds in the test as they had when using the application.

Some pupils had problems and difficulties in their reading as they had only been to school for one term in their first year, as the school was closed for one term and the teaching suspended due to the spread of Covid-19. There was no online platform for teaching the second semester of the first year of school

The application could help the students without any external help from their parents or teachers as they played independently, and the application contained pictures and read-aloud feature in conjunction with the texts. Also, the application has the potential to create many different stories that are changed depending on the elements selected by the learners. When they select different characters, backgrounds, activities and emotions for their stories, the amount of vocabulary that they will be able to read will increase, which will also enhance their linguistic skills.

Many of the children liked the idea of sharing their stories on the website where they could see their own stories as well as their friends' stories. They also liked the fact that they could comments on each other's stories; and doing this enhanced their ability to criticize, increased their self-motivation to improve their reading, afforded an element of competition and excitement as well as providing an opportunity to exercise patience while waiting for peers' comments as well as their stories.

Some children tried to improve how they read their stories for the website, especially in terms of volume and clarity. Moreover, once they knew that they could listen to each other's stories, they said that they could help each other with pronouncing difficult words and correcting each other. Doing this helps children to work in groups and teams, which in turn boosts cooperative learning. Unfortunately, due to the Covid-19 situation and school closure, this meant that evidence of this could not be obtained. Had the study been conducted in schools, where pupils were divided into groups where they could interact with each other face-to-face, and then observed during the three practical sessions, evidence of collaboration of this kind could have been produced.

In all three sessions, the application seemed easy to use for the children and most became very familiar with the system, played independently with it and made good progress during the three sessions.

5.4.2 Student Post experiment Questionnaire

The survey was utilized to assess system usability and evaluate student satisfaction of the system. The questionnaire consisted of 31 Likert scale close ended questions with smiley faces ranging from very sad to very happy and 2 open-ended questions (Appendix 5.5). The researcher read the questions to the students and captured their reply.

The data recorded from the post-experiment questionnaire and its analysis is given below.

5.4.2.1 Part A: Scalable Measurement Questionnaire Analysis

The experimental students were questioned about describing various features of the developed system, which included their feeling, attitudes and behaviours towards the using system. Each characteristic was measured by statements that used a differing 5-point Likert scale ('Strongly agree', 'Agree', 'Neutral', 'Disagree' and 'Strongly disagree').

5.4.2.1.1 System Usability (SU)

The System Usability factor was measured using fifteen items in the student questionnaire. The collected data was about student perception of system usability. The measuring items are shown in Table 5.1 and the results are shown in a combined graph in Figure 5.7. The 5-point Likert scale were (5) Strongly agree, (4) Agree, (3) Neutral, (2) Disagree and (1) Strongly disagree.

Factor	Item	Statement	5	4	3	2	1	Mean	SD	Rank
System Usability	SU1	The application is easy to use	23	2				4.92	0.276	4
	SU2	I can read at my own pace	13	9	3			4.40	0.707	10
	SU3	The content provided enhanced my learning	21	3	1			4.80	0.500	6
	SU4	Reading on the screen is easy	19	4	1	1		4.64	0.757	8
	SU5	The words are easy to read.	19	5	1			4.72	0.541	7
	SU6	The words are easy to understand.	21	4				4.84	0.374	5
	SU7	Creating the story in the novice level is easy	23	1				4.95	0.204	3
	SU8	Creating the story in the expert level is easy and helps me to use my imagination	8	3				4.72	0.467	7
	SU9	The use of read aloud is easy	24	1				4.96	0.200	2
	SU10	The sounds help me to read the words and sentences	24	1				4.96	0.200	2
	SU11	The sound is clear	23	2				4.92	0.276	4
	SU12	The pictures look good and are easy to understand	23	2				4.92	0.276	4
	SU13	The pictures help me to understand the words and sentences	25					5.00	0.000	1
	SU14	Sharing the story is easy	6	5				4.54	0.522	9
	SU15	This application has all the functions and capabilities I need	21	4				4.84	0.374	5

Table 5.1: Measured Items for System Usability Factor

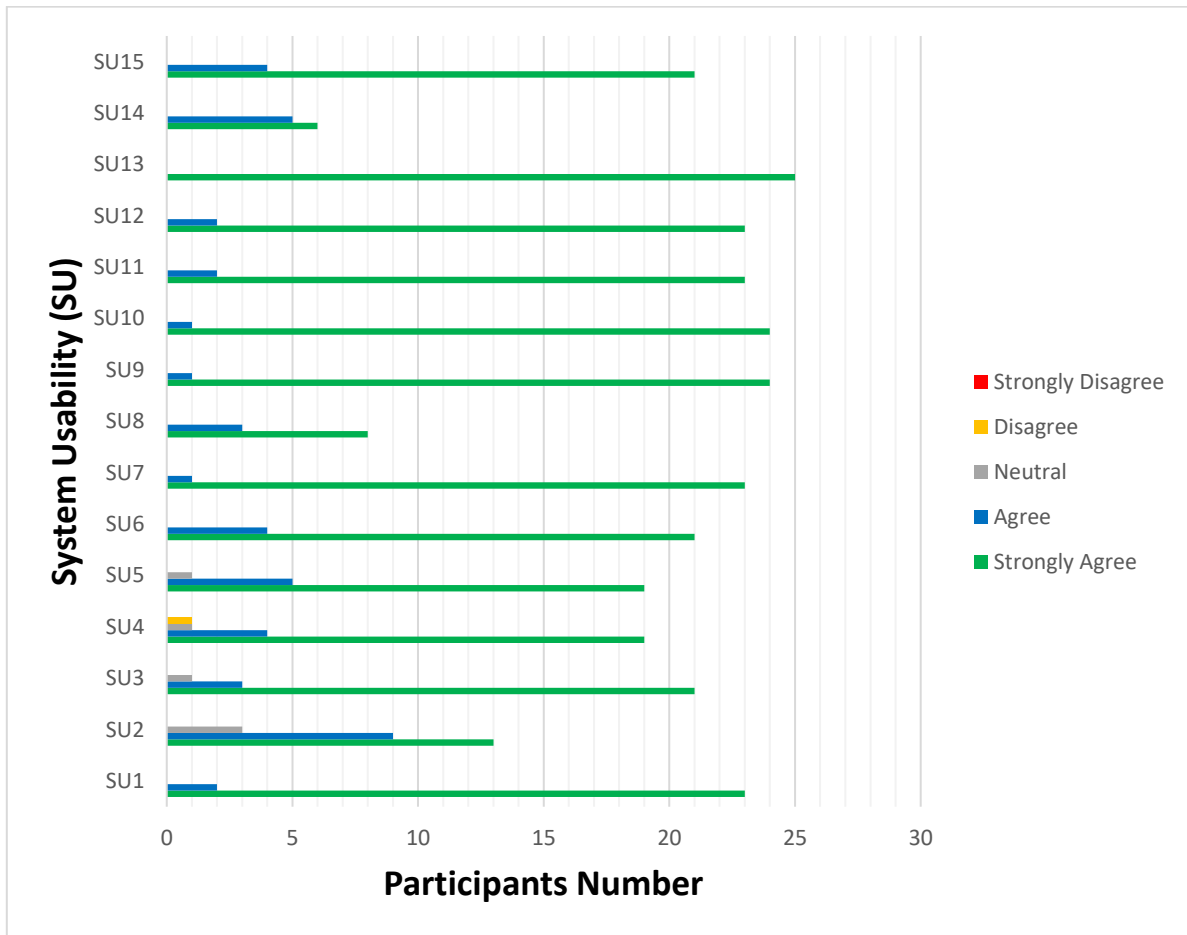


Figure 5.7: Results of Measured Items for System Usability Factor

As can be seen from Figure 5.7, most of the students' responses were positive towards using the system. The majority of responses were agree or strongly agree and there was only one negative response about reading on the screen is easy and this response was from the student with a visual impairment.

There was a single student who did not reach the create story on the novice level, and there were 14 students who did not reach and create the story on the expert level. The researcher did not read the statement SU7, SU8 and SU14 to those students as they did not share their stories.

Item SU1 asked students if they believed that the application is easy to use. Figure 5.7 shows that Twenty three students strongly agreed with the statement (92%) and two students agreed with the statement (8%). The mean score showing a high level of agreement of students perception of the system's ease of use ($M=4.92$, $SD=0.276$).

Item SU2 questioned if students thought that they can read at their own pace. Figure 5.7 shows that Thirteen students strongly agreed (52%), nine students agreed (36%) and three students were neutral (12%) with the statement. The average score provides a high level of agreement towards that the students can read at their own pace ($M=4.40$, $SD=0.707$). This could be because the existence of the mothers next to their children as they seemed in a hurry and some of them said to their child “be quick”, “read quickly” and so.

The students were questioned in item SU3 whether the content provided in the application enhanced their learning. Figure 5.7 shows Twenty one students strongly agreed (84%), Three students agreed (12%), and one student was neutral (4%). The mean score indicates a high level of agreement that the content provided in the application enhanced students’ learning ($M=4.80$, $SD=0.500$).

Item SU4 questioned participants whether they found reading on the screen is easy. Figure 5.7 illustrates that Nineteen students strongly agreed (76%), Four students agreed (16%), One neutral (4%) and only one student disagreed (4%). The average score shows that students in agreement with that reading on the screen is easy ($M=4.64$, $SD=0.757$).

In Item SU5 students were asked if they found the words are easy to read. Figure 5.7 shows that Nineteen students strongly agreed (76%), five students agreed (20%) and one student was neutral (4%). The mean score indicates positive feedback from the students that the words are easy to read ($M=4.72$, $SD=0.541$).

Item SU6 asked the students if they found the words easy to understand. Figure 5.7 shows that Twenty-one students strongly agreed (84%) and four students agreed (16%). The mean score indicates positive feedback from the students that the words are easy to understand ($M=4.84$, $SD=0.374$).

In Item SU7 students were questioned if they thought that creating the story in the novice level is easy. Figure 5.7 shows that Twenty-three students strongly agreed (96%) and one student agreed (4%). As explained earlier, only one student was unable to create the stories within three sessions period. The mean score indicates a very high agreement level that creating the story in the novice level is easy ($M=4.95$, $SD=0.204$).

In Item SU8 students were questioned if they thought that creating the story in the expert level is easy and helps them to use their imagination. Figure 5.7 shows that Eight students strongly agreed (72.7%) and three students agreed (27.2%). As explained earlier, only Eleven students

were able to create and share their stories by the end of the third session whereas fourteen students were unable to do so. The average score shows a very high agreement level that creating the story in the expert level is easy and helps them to use their imagination ($M=4.72$, $SD=0.467$).

Item SU9 asked the students if they found the use of read aloud is easy. Figure 5.7 shows that Twenty-four students strongly agreed (96%) and one student agreed (4%). The mean score indicates a very high agreement level that the use of read aloud is easy ($M=4.96$, $SD=0.200$).

Item SU10 asked the students if they found the sounds help them to read the words and sentences. Figure 5.1 shows that Twenty-four students strongly agreed (96%) and one student agreed (4%). The mean score indicates a very high agreement level that the sounds help the students to read the words and sentences ($M=4.96$, $SD=0.200$).

In Item SU11 students were asked if they found the sound is clear. Figure 5.7 shows that Twenty-three students strongly agreed (92%) and Two students agreed (8%). The mean score indicates a very high agreement level that the sound is clear ($M=4.92$, $SD=0.276$).

Item SU12 asked the students if they found the pictures look good and are easy to understand. Figure 5.7 shows that Twenty-three students strongly agreed (92%) and Two students agreed (8%). The mean score indicates a very high agreement level that the pictures look good and are easy to understand ($M=4.92$, $SD=0.276$).

Item SU13 questioned the students if they thought the pictures helped them to understand the words and sentences. Figure 5.7 shows that all of the Twenty-five students strongly agreed (100%). The mean score indicates a very high agreement level that the pictures help students to understand the words and sentences ($M=5.00$, $SD=0.000$).

The students were questioned in item SU14 whether sharing the story is easy. Figure 5.7 shows that six students strongly agreed (54.5%) and five students agreed (45.4%). The mean score indicates a high agreement level that the sharing the story is easy ($M=4.54$, $SD=0.522$).

Item SU15 questioned the students if they thought that this application has all the functions and capabilities they need. Figure 5.7 shows that Twenty-one students strongly agreed (84%), and four students agreed (16%). The mean score indicates a very high agreement level that this application has all the functions and capabilities the students need. ($M=4.84$, $SD=0.374$).

The overall mean score for the system usability factor was found to be high in terms of agreement $M= 4.82$, $SD=0.191$.

From the usability factor above, it is clearly appears that the students had a positive perception of the application features with a high degree of agreement for almost all statements by most of the students. However, it is useful to identify which is the most likable feature for the students. Table 5.1 includes the statements rank based on their mean.

As can be seen from Table 5.1 almost all statements have a very high level of agreement among students except SU2 and SU14. The highest agreement was achieved for SU13, which refers to pictures helping the students to understand the words and sentences, followed by SU9 and SU10, which refer to the use of the read aloud feature is easy and the sounds help the students to read the words and sentences. Followed by SU7 which relates to creating the story in the novice level being easy and SU1 which relates to the application being easy to use. Even though the majority of responses were strongly agree and agree, the lowest rank was for SU14 (sharing the story is easy) as only 11 students were able to reach the expert level followed by SU2 (students can read at they own pace). This could be because the existence of the mothers next to their children as they seems in a hurry and some of them said to their child “be quick”, “read quickly” and so.

5.4.2.1.2 User satisfaction (US)

User satisfaction (US) is another factor used to measure sixteen items related to the mobile learning application. The measuring items are shown in Table 5.2 and the results are shown in a combined graph in Figure 5.8. The 5-point Likert scale were (5) Strongly agree, (4) Agree, (3) Neutral, (2) Disagree and (1) Strongly disagree.

Table 5.2: Measured Items for User Satisfaction Factor

Factor	Item code	Statement	5	4	3	2	1	Mean	SD	Rank
User Satisfaction	US1	When I see my friends stories I feel happy and this encourages me to read	22	2	1			4.84	0.472	5
	US2	The application helped improving my reading skills	24	1				4.96	0.200	2
	US3	This application is useful for creating stories	21	3				4.87	0.337	4
	US4	Creating my own stories was fun	24					5.00	0.000	1
	US5	I want to use the application for improving my reading skills	21	4				4.84	0.374	5
	US6	I prefer using the application for increasing my reading ability than using a book	23	1		1		4.84	0.624	5
	US7	I enjoyed using the application	23	2				4.92	0.276	3
	US8	I would like to keep using this application to read	22	2	1			4.84	0.472	5
	US9	I learned to read quickly using this application	21	4				4.84	0.374	5
	US10	I want to play again	22	2	1			4.84	0.472	5
	US11	I want to play longer	19	5	1			4.72	0.541	7
	US12	I feel I learn more in this application	24	1				4.96	0.200	2
	US13	I feel motivated to read when I use the application	25					5.00	0.000	1
	US14	I feel engaged when I use the application	15	9	1			4.56	0.583	8

	US15	I was happy when I created a story using the application	24					5.00	0.000	1
	US16	I feel happy when I read my story	21	2	1			4.83	0.481	6

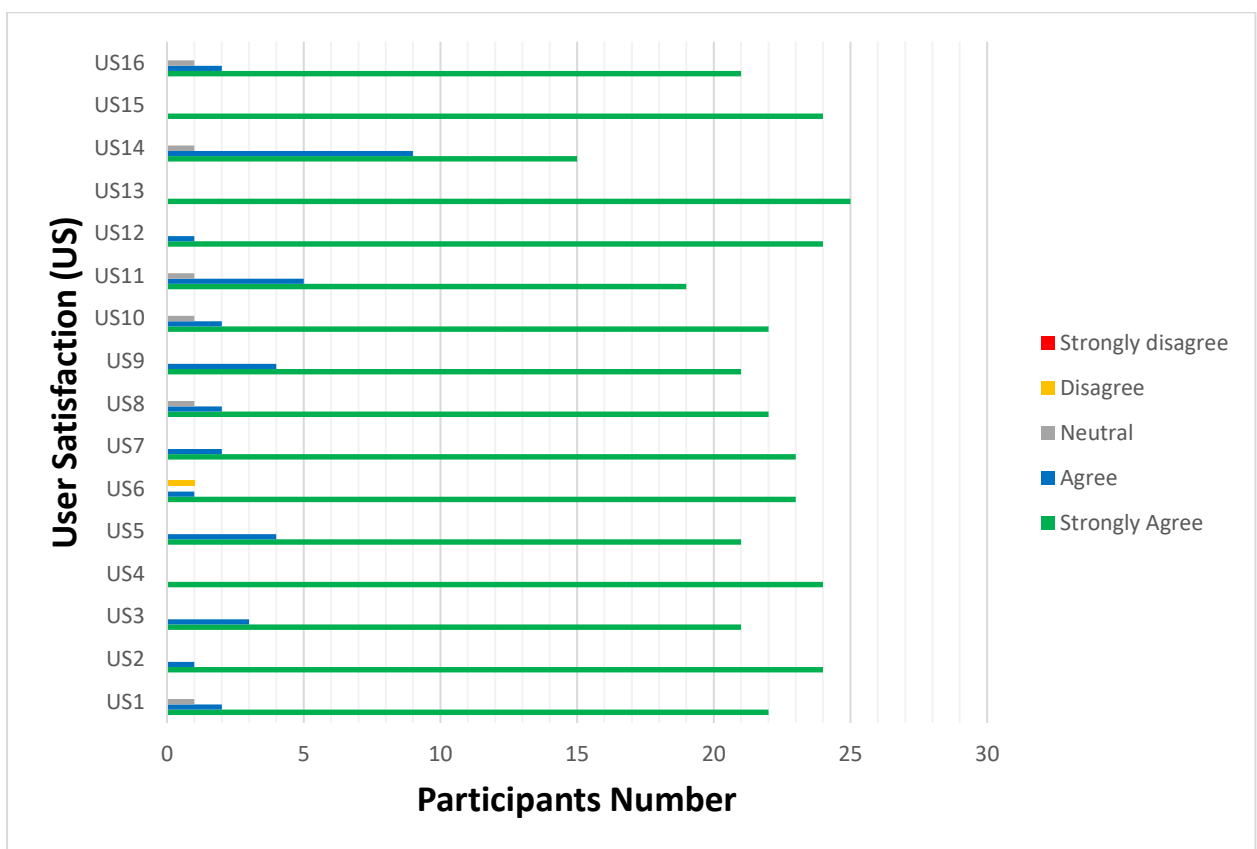


Figure 5.8: Results of Measured Items for User satisfaction Factor

Figure 5.8 shows that most of the students were satisfied using the system with the majority of responses being strongly agree or agree and with only one negative response regarding preferring using the application for increasing my reading ability than using a book.

As there was a student who did not reach the creating stories on either level, the researcher did not ask her the statements of US3, US4, US15 and US16.

Item US1 asked students whenever they see their friends stories they feel happy and this encourages them to read. Figure 5.8 shows that Twenty-two students strongly agreed (88%), two students agreed (8%) and one student was neutral (4%). The mean score showed a high level of agreement of students perception of whenever they see their friends stories they feel happy and this encourages them to read ($M=4.84$, $SD=0.472$).

Item US2 asked students if they thought the application helped improving their reading skills. Figure 5.8 shows that Twenty-four students strongly agreed (96%) and one student agreed (4%). The mean score showing a high level of agreement that the application helped improving students reading skills ($M=4.96$, $SD=0.200$).

Item US3 asked students if they thought this application is useful for creating stories. Figure 5.8 shows that Twenty-one students strongly agreed (88%) and three student agreed (12%). The mean score showing a high level of agreement that this application is useful for creating stories ($M=4.87$, $SD=0.337$).

Item US4 questioned the students if they found creating their own stories was fun. Figure 5.8 shows that all of the Twenty-four students strongly agreed (100%). As explained earlier only one student who was unable to create her stories during the three session. The mean score indicate a very high agreement level that the students found creating their own stories was fun ($M=5.00$, $SD=0.000$).

The students were questioned in item US5 whether they want to use the application for improving their reading skills. Figure 5.8 shows that Twenty-one students strongly agreed (84%) and four students agreed (16%). The mean score indicates a high agreement level that students want to use the application for improving their reading skills ($M=4.84$, $SD=0.374$).

Item US6 asked students if they prefer using the application for increasing their reading ability rather than using a book. Figure 5.8 shows that Twenty-three students strongly agreed (92%), one student agreed (4%) and only one student (4%) disagreed with the statement. The mean score showing a high level of agreement that the application helped improving students reading skills ($M=4.84$, $SD=0.624$).

The students were asked in item US7 whether they enjoyed using the application. Figure 5.8 shows Twenty-three students strongly agreed (92%), and two student agreed (8%). The mean score indicates a very high level of agreement that the students whether enjoyed using the application ($M=4.92$, $SD=0.276$).

In item US8 students were asked if they would like to keep using this application to read. Figure 5.8 shows that Twenty-two students strongly agreed (88%), Two students agreed (8%) and one student was neutral (4%). The mean score indicate a very high agreement level that the students would like to keep using this application to read ($M=4.84$, $SD=0.472$).

The students were asked in item US9 whether they learned to read quickly using this application. Figure 5.8 shows Twenty-one students strongly agreed (84%), and four student agreed (16%). The mean score indicates a very high level of agreement that the students learned to read quickly using this application ($M=4.84$, $SD=0.472$).

Item US10 asked students if they want to play again. Figure 5.8 shows that Twenty-two students strongly agreed (88%), two student agreed (8%) and one student was neutral (4%). The mean score showing a high level of agreement that they want to play again ($M=4.84$, $SD=0.472$).

Item US11 asked students if they want to play longer. Figure 5.8 shows that Nineteen students strongly agreed (76%), five students agreed (20%) and one student was neutral (4%). The mean score showing a high level of agreement that they want to play longer ($M=4.72$, $SD=0.541$).

The students were questioned in item US12 whether they felt they learn more in this application. Figure 5.8 shows Twenty-four students strongly agreed (96%), and one student agreed (4%). The mean score indicates a very high level of agreement that the students felt they learn more in this application ($M=4.84$, $SD=0.472$).

The students were questioned in item US13 whether they felt motivated to read when they use the application. Figure 5.8 shows all the Twenty-five students strongly agreed (100). The mean score indicates a very high level of agreement that the students felt motivated to read when they use the application ($M=5.00$, $SD=0.000$).

The students were questioned in item US14 whether they felt engaged to read when they use the application. The results here were more variable than for other questions and this could because the children did not understand the meaning of “engagement” even though the researcher explained this word. Figure 5.8 shows fifteen students strongly agreed (60%), nine students agreed (36%), and one student was neutral (4%). The mean score indicates a high agreement level of the students felt engaged to read when they use the application ($M=4.56$, $SD=0.583$).

Item US15 asked students if they were happy when they created a story using the application. Figure 5.8 shows that all the Twenty-four students who created their stories strongly agreed (100%). As explained earlier, one student was unable to create her stories during the three sessions. The mean score showing a high agreement level that the students were happy when they created a story using the application ($M=5.00$, $SD=0.000$).

The students were asked in item US16 whether they felt happy when they read their story. Figure 5.8 shows Twenty-one students strongly agreed (88%), two students agreed (8%) and one student was neutral (4%). The mean score indicates a very high level of agreement that the students felt happy when they read their story ($M=4.83$, $SD=0.481$).

The overall user satisfaction mean score was found to be $M= 4.86$, $SD= 0.168$ which indicates high agreement level. Overall, the average score of system usability and user satisfaction is very similar.

From the user satisfaction factor above, it is clearly appears that the students had a positive reaction towards using the application with a high degree of agreement for almost all statements by most of the students. However, it would be useful to identify which is the most satisfying feature for the students. Table 5.2 shows the statements rank based on their mean.

As can be seen from Table 5.2 almost all statements have a very high level of agreement among students. The highest agreement was achieved for US4, US13 and US15 ,which refer to that the creating my own stories was fun, students felt motivated to read when they use the application and they were happy when they created a story using the application. Followed by US2, which refer to the application helped improving their reading skills, and US12 ,which refer to feeling that students learn more in this application. Even though the majority responses were strongly agree and agree, the lowest rank was for SU11 which relates to whether they want to play longer followed by SU14 which refers to feeling engaged when they use the application. This could be because the students did not understand the meaning of engagement even after it was translated in Arabic language.

5.4.2.2 Part B: Qualitative Analysis: Ease of Use

In this section of the questionnaire, students were asked about the ease of use of the system and any issues they encountered. All experimental groups responded to these questions. The following tables summarizes the opinions of the students regarding the ease of use of the system parts.

Table 5.3: Student Opinions about The Ease of use of The System Usability

Easy to Use	Percentage
Everything/ All	52%
Words	28%
sentences	24%
Creating stories and reading them/ Creating stories in the novice level	48%
The use of sounds	16%
Pictures	12%
Texts/ Reading from the application	16%

Table 5.4: Student Opinions about The difficult of use of The System Usability

Difficult to Use	Percentage
Nothing difficult	72%
Stories sentences are quite long	24%
Creating stories in the expert level	8%
The font is small	4%

As can be seen from Table 5.3 and Table 5.4, presents results for various features of the application regarding the ease or difficulty of their use.

Easy Parts of the system

Students were varied when they mentioned the easy parts of the system. The results show that 52% of the students believed that all and/or everything in the application was easy to use. Some students mentioned specifically some features such as: pictures (12%), texts (16%), words (28%), sentences (24%), creating stories and reading them (48%) and the use of the sounds (16%).

A student commented “*The application start from words to sentences and stories. Reading, words, use of the sounds, When I created the stories on both levels, you heard the stories that you shared. I learned reading while I playing. creating the stories by dragging pictures. I create story by selecting the pictures that I want, I can delete the picture that I already chose*

if I changed my mind. The sounds because I can hear the words and I repeat after it. Reading the story.

The pictures because when I see them, It will help me to read. Sharing my stories because I can hear my friends' stories and they can hear my stories."

Another commented *"The application teaches me how can I create story and read it, How to read the words and benefit from them, it help me to learn to read"*.

Difficult parts of the system

Most of the student said nothing is difficult (72%). However, 24% of the students mentioned that the sentences in the stories are quite long. Student said *"Reading stories is quite difficult because it is quite long"*. Also, 8% mentioned that creating stories with no questions i.e. creating stories in the expert level is quite difficult. Moreover, 4% mention that the font of the application is small.

5.4.3 Parents survey findings

This section will discuss the results of parents' surveys which are aimed at acquiring information about the participating children in this study, their experience of technology use and home literacy environment (appendix 5.4). The results from the questionnaire are described below; these reflect general information about students, their use of technology at home and literacy information.

5.4.3.1 Child information

Here, parents were asked to provide general child information such as gender, age, learning disability and reading ability as shown in Table 5.5.

Table 5.5 Results of child information

Questionnaire item	Measure	Percentage
Child gender	Male.	32.50%
	Female.	67.50%
Child age	7	50.00%
	8	45.00%
	9	5.00%

Child learning disability	☐ Yes	10.00%
	☐ No	90.00%
	☐ Prefer not to say	0%
Child reading ability in Arabic	☐ Very fluent	5.00%
	☐ Fluent	35.00%
	☐ Normal Fluency	27.50%
	☐ Not fluent	25.00%
	☐ Not fluent all	7.500%
	☐ Prefer not to say	

As can be seen from Table 5.5, more than half of the participated students were female 67.50% while 32.50%. were male. The participant age are varied ranged 7,8 and 9 with 50%, 45% and 5% respectively. Although 90% of the students do not have learning disability, 10% stated they do have a learning disability (4 children). For Child reading ability in Arabic, students varied of their ability of reading, 5% are very fluent, 35% are fluent, 27% are having normal fluency, 27% are not fluent, and 7.50% are not fluent at all. Therefore, the results show a good spread of ability prior to using the system.

5.4.3.2 Technology use

Here, the parents were asked about the general use of technology at home and the children's' experience of using technology.

Table 5.6 Results of technology use (part 1)

Questionnaire item	Measure	Percentage
Do you have internet at home	☐ Yes	100%
	☐ No	0%
type of technology do you own at home	☐ Smartphone	80.0%
	☐ Tablet	65.0%
	☐ TV	100.0%
	☐ Laptop or Desktop	67.50%
	☐ Video games	42.50%

Which technology devices do you use with your child	☐ Smartphone ☐ Tablet ☐ TV ☐ Laptop or Desktop ☐ Video games	50.0 % 60.0% 100.0% 42.50% 15.0%
Which devices does your child could use independently:	☐ Smartphone ☐ Tablet ☐ TV ☐ Laptop or Desktop ☐ Video games	25.0% 65.0% 45.0% 10.0% 17.50%
What is/ are the most preferred technology devices your child enjoys using:	☐ Smartphone ☐ Tablet ☐ TV ☐ Laptop or Desktop ☐ Video games	30.0% 70.0% 45.0% 5.0% 22.50%
What does your child generally do (activity) on smart phone/tablet devices.	☐ Reading ☐ Listening to music ☐ Drawing ☐ Playing games ☐ Browsing the internet Other: Taking pictures and chatting Watching YouTube	17.50% 27.50% 32.50% 92.50% 25.0% 2.50% 2.50%

As can be seen in Table 5.6, all parents have internet access at their home. All of them have TV, 80% have smartphone, approximately 65% of them own Tablet, laptop or desktop and the least technology devices are video games 42.50%. All parents confirm that their use TV with their child, 60% use tablet with their child while 50% use smartphones with their child, 42% use laptop or desktop and the least device they use is video gaming 15%.

The most devices that the children can use independently are tablets (65%) and TV (45%) while the least are smartphone (25%), video games (17.50%) and laptop or desktop (10%). Similarly, the most preferable devices for the children are tablets (70%) and TV (45%) while the least are smartphone (30%), video games (22.50%) and laptop or desktop (5%). Playing games are the most activity that the children generally do while using smartphone or tablet (92.50%) while reading is the least activity (17.50%). Drawing, listen to music and browsing the internet are other activities that children do with (32%), (27%) and (25%) respectively. A few parents mention that their children watching YouTube videos (2.5%) and taking pictures and chatting (2.5%). Therefore, all children have access to an internet enabled device and this would suggest a good level of base internet familiarity

In Table 5.7, during weekdays 32% of the children spent 3 to 4 hours, 27.50% spend 1-2 hours, 22% spend 2-3 hours. 5% Only 10% of the student spend 5 hours or more, one child does not use such devices during the weekdays. On the other hand, in the weekend, 30% of the student spend 2 to 3 hours, 22% spending 3-4 hours, 17% spend 1- 2 hours and 5 hours or more. 7% spend less than hour and 5% do not use technology. Therefore, these results refer to a good level of technological experience when using the internet and devices.

80% of the students use mobile/tablet applications by themselves while 10% of the student need help or cannot use it at all. 65% of the children needs to get their parents' permission before using technology, 32% sometimes required to do so while 2.5% never asked for permission. 60% of the students have their own device while 40% do not.

Table 5.7 Results of technology use (part 2)

How many hours per day does your child engage in technology use (in weekdays Sunday to Thursday)	☐ Not at all	2.5 %
	☐ Less than an hour	5.0%
	☐ 1-2 hours	27.5%
	☐ 2-3 hours	22.50%
	☐ 3-4 hours	32.50%
	☐ 5 hours or more	10.0%

How many hours per day does your child engage in technology use (in weekend days Friday and Saturday)	☐ Not at all ☐ Less than an hour ☐ 1-2 hours ☐ 2-3 hours ☐ 3-4 hours ☐ 5 hours or more	5.0% 7.50% 17.50% 30.0% 22.50% 17.50%
1. Does your child operate the mobile/ tablet applications?	☐ by themselves (alone) ☐ with help ☐ not at all.	80.0% 10.0% 10.0%
2. Is your child required to obtain parent permission before using technology?	☐ Yes always ☐ Sometimes ☐ Never	65.0% 32.5% 2.50%
3. Does your child own a device?	☐ Yes ☐ No	60.0% 40.0%

According to Table 5.7, 72.50% of the students use portable technology devices for both learning and entertainment. 10% of the students use these devices for learning while 17.50% for entertainment. The most usable devices for learning are iPad (35%), iPhone (32%), Laptop (30%) and Huawei tablets (27.50%) while the least devices are Android smartphones (7.5%) and Galaxy tablets (5%). The most usable devices for entertaining are iPad (45%), iPhone (25%), and Huawei tablets (22.50%) while the least devices are Android smartphones (7.5%), Galaxy tablets (2.5%) and Laptop (7.5%). (20%) of the students use the portable devices since age of 3, (20%) since age of 7, (15%) since age of 6, (10%) since age 4 and 5, (5%) since age of 2 while (20%) have never used portable devices.

Table 5.8 Results of technology use (part 3)

4. In what way(s) does your child use portable technology devices?	☐ Learning ☐ Entertainment ☐ Both	10.0% 17.50% 72.50%
5. When using portable technology for LEARNING, what device(s) does your child use? <i>(select all that apply)</i>	☐ iPad ☐ iPhone ☐ Android smartphone ☐ Galaxy tablet ☐ Laptop ☐ Amazon Kindle ☐ Huawei Tablets	35.0% 32.50% 7.50% 5.0% 30.0% 0 27.50%
6. When using portable technology for ENTERTAINMENT, what device(s) does your child use? <i>(select all that apply)</i>	☐ iPad ☐ iPhone ☐ Android smartphone ☐ Galaxy tablet ☐ Laptop ☐ Amazon Kindle ☐ Huawei Tablets	45.0% 25.0% 7.50% 2.50% 7.50% 0 22.50%
7. Please indicate how long your child has been using portable devices:	☐ Has never used a portable device ☐ Since age of 2 ☐ Since age of 3 ☐ Since age of 4 ☐ Since age of 5 ☐ Since age of 6 ☐ Since age of 7	20.0% 5.0% 20.0% 10.0% 10.0% 15.0% 20.0%

Table 5.8 shows the type of devices that child can operate. The most devices that students can operate are TV (65%), iPad (60%) and smartphone (57%). These results are similar (Smahel et al, 2020) study about EU kids online 2020 which results to that smart TVs or internet enabled TVs are more popular than tablet in Italy and Spain.

Table 5.9 Results of technology use (part 4)

Devices	Does not know	Limited	Adequate	Very Well
Television	2.50%	10.0%	22.50%	65.0%
Computer or laptop	27.50%	27.50%	30.0%	15.0%
iPad	2.50%	7.50%	30.0%	60.0%
Video Game System	45.0%	20.0%	12.50%	22.50%
Smart Phone	5.0%	7.50%	30.0%	57.50%

5.4.3.3 Home literacy environment

Here, the home literacy environment is explored for the children. As in Table 5.10, mothers are the most responsible person for teaching the child at home while fathers take some responsibility. Siblings and tutor are the least likely people to teach children with (5%) and (2.50%) respectively. 62.50% read with their children while 37.5% do not. The majority of children are being read to by their parents. Approximately half of the parents mention that they began reading to their children at the age of 4 and forward. Approximately half of the children own less than 5 books (45%), (22.50%) own between 5 to 10 books, (7.5%) own between 10 to 15 books and more while (17.50%) do not own any books.

Most of the parents prefer reading for their children from books (80%) while (20%) prefer to read from the smartphones/tablets. The explained reasons for reading from books are as follows; because it is the origins, they want to show the importance of the books, to make their child love reading from books, better and easier to read from, easy to get, easy to read, have pictures and easy to browse. Those who prefer reading from smartphones or tablets because there are more options for stories are available, more varieties, they can access to stories anywhere and anytime, easy to get stories, faster to access to online books.

When parents asked about their children reference of reading stories from book or from smartphones/tablets, 75% they said that their children prefer stories read from books while 25% said their children prefer smartphones/tablets. They mentioned the reason of choosing books

because; the children used to read from books, their children choose the stories by themselves, because of the existence of pictures, because the mothers prefer the books, to avoid the mobile rays and to protect their children's eyes. A few parents said that they do not know the reason. On the other hand, parents said that their children prefer smartphones/tablets because; there are many stories on YouTube, faster to choose the stories that their children want to read, to say the pictures and listen to the sounds and the child prefer to listen to audio stories.

When parent were asked about what their children prefer to use and read from by themselves, 65% said books while 35% said smartphone/tablet. The reason why their children prefer books because they are used to read from books, to mimic their parents, it is more clear to read from books, children can close the book when they want, the existence of pictures, easy and better from reading from the devices. On the other hand, parents said that their children prefer to use smartphone/tablet and read from by themselves because, children can read and listen at the same time, fast, learn fast, to play, the child does not like books, children like using smartphone/tablet and they like using YouTube because it has more stories and songs.

Table 5.10 Results of Home literacy environment (part 1)

Questionnaire item	Measure	Percentage
Who is responsible for teaching your child at home?	☐ Mother ☐ Father ☐ Siblings ☐ Tutor ☐ No one	97.50% 12.50% 5.0% 2.50% 0
8. Do you read with your child?	☐ Yes ☐ No	62.50% 37.50%
How old was your child when you began reading to him/her? (optional)	From 6 months 2 years 3 years 4 years 5 years 6 years 7 years	2.5% 10% 15% 10% 20% 12.5% 7.5%

How many books your child own?	☐ Less than 5 books ☐ 5-10 ☐ 10-15 ☐ More than 20 ☐ None	45.0% 22.50% 7.50% 7.50% 17.50%
Do you prefer reading stories for your child from a book or stories smartphone/tablet? Why?	☐ book ☐ smartphone/tablet	80.0% 20.0%
Does your child prefer stories read from a book or stories on the smartphone/tablet? Why?	☐ book ☐ smartphone/tablet	75.0% 25.0%
What would your child prefer reading to use themselves? Why?	☐ book ☐ smartphone/tablet	65.0% 35.0%

Table 5.11 shows the parents opinion about using technology, smartphones, tablets and laptops in the classroom for teaching and learning reading. A 5-point Likert scale (Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree) has been used to obtain their opinion. To simplify the analysis, the answers were combined as Agree (Agree and Strongly Agree) and Disagree (Disagree and Strongly Disagree).

It is clear from Table 5.11 that the majority of the parents agreed to increase the use of technology, smartphones, tablets and laptops in the classroom for teaching and learning reading. This could be because parents saw lots of benefit of using these devices such as they are easy to use by their children and their child uses them independently. These devices also provide speed, flexibility and ease of learning. These devices also contains interactive applications which provide interactive learning where children can learn while they have fun.

Table 5.11 Results of Home literacy environment (part2)

Item statement	Agree	Natural	Disagree
Schools should increase the use of technology in the classroom for teaching and learning reading	25	10	5
Schools should increase the use of smartphone in classroom for teaching and learning reading	16	10	14
Schools should increase the use of tablet in the classroom for teaching and learning reading	19	12	9
Schools should increase the use of laptop in the classroom for teaching and learning reading	23	9	8

5.4.4 Teacher Interviews findings

This study used NVivo version 12 (QSR International Pty Ltd, 2018) to analyse the interviews' transcripts and identify and interpret the descriptive themes of the interviews.

5.4.4.1 The use of technology in the classroom

5.4.4.1.1 Mixed technology types

During the online learning, the teachers used the virtual class platform called *Madrasty* (my school) through Microsoft Teams as well as PowerPoint presentations that they had made, educational YouTube videos, the Ein¹ educational channels and educational games. Teachers use shared screen features to present videos, make presentations and display worksheets that they had prepared for the lesson. However, ordinarily in schools, the technologies that are used in the classroom are computers, laptops, document cameras (visual presenters), smart boards (interactive boards) or/ and the projector. Teachers do not allow their pupils to use the laptop allocated to the teacher, and there was a general feeling that this would waste time as indicated by Teacher 3's comment: *"Allowing pupils to use the laptop would waste time because I have 30 children in my class, and all of them would want to use it, It is not like if I just had 10 or 15 pupils"*. Also, pupils cannot use their own devices. Teacher 2 said: *"It is forbidden for any pupil to bring devices to the school; the only devices are with the teacher"*.

¹ Provided by the Ministry of Education in Saudi Arabia

5.4.4.1.2 *Reasons for using technology in the class*

The teachers gave many reasons for using technology in the classroom; and many considered it as a necessity in the classroom, seeing technology as indispensable in education. They believed that helped to entertain pupils and change the classroom's atmosphere as it could bring enjoyment to the class. However, technology was perceived as complementary to books and an additional means for teaching; for example, Teacher 2 said: *"Technology is a help, but books are the foundation because we cannot 100% rely on technology"*.

Technology was felt to attract pupils and increase their interaction, and was arguably a more exciting way of learning than formal textbooks. Teacher 1 said: *"Honestly, I noticed that when teaching was without interactive screens (smart boards), there was no interaction. But last year, when an interactive screen was put in my classroom, the children began to get excited and asked me to play some clips, and they were interacting, and the class became more fun, I mean better than the traditional one, especially for the elementary grades, first, second and third years"*.

The teachers thought that technology assisted in explaining difficult information from textbooks, and delivered information quickly, as well as helping pupils to retain it more easily. All the teachers displayed information with pictures, videos or cartoons that related to the lesson, if a teacher knew already when she prepared for the lesson that she might be asked about specific information and/or if she had been asked about it outside of the lesson. Teacher 1 commented: *"I can easily display [information] on the screen with pictures or videos through the educational channels known to me, especially if it is equipped with animations that explain the information and the pupils understand it more quickly because children tend to watch cartoons and because they easily get bored"*

Technology was perceived as preventing pupils from getting bored or sleepy. Teacher 1 said: *"Especially in the elementary grades, children get bored after the first 10 minutes of class, and how can I avoid boredom? Every so often I can show them an educational video or educational animation, and these things distract from boredom and monotony, unlike when it is just me explaining and the books are open, then the pupils will feel sleepy"*. However, Teacher 2 mentioned that technology only motivated pupils who could understand it and gave an example: *"We are in a foundation stage attached to the first grade. If a pupil is motivated, knows the letters, reads them correctly, and can read them, then this technology is a source of motivation to him. But if he has been failing from the start, and does not know the letters, he*

cannot know what he reads, so [the technology] will not motivate him because he cannot solve the problems or enjoy the task”.

Another teacher mentioned that there was a difference between the current generation and the past generation, in that the traditional learning style, the blackboard and teacher explanation is not enough for the current generation. Children have become more aware than before how the use of technology encourages them and gives them the desire to learn. The fact that many of them have easy access to electronic equipment means that they expect that type of access in the classroom and thus are less engaged by traditional methods. This point was supported by the post-study survey where all but one of the children mentioned that they preferred using the developed novel application rather than a book to increase their reading ability. Teacher 1 said: *“The new generation tends to use technology in general, and this is the same for reading and writing, pupils desire to use technology, especially if it is supported by pictures or sounds, then they want to learn and will not get bored using it”* and *“Now the generation has evolved, and every time you introduced new technology like the iPad to them, they will become eager to learn more”.*

The school closure which necessitated moving to online learning and virtual classes has helped teachers and pupils to use technology and improved their skills. For example, Teacher 1 indicated that: *“Due to the Madrasaty (my school) platform, the pupils have become more used to using devices, meaning they know how to access the platform and use the technology, so their skills have developed, my skills have developed, and I am using technology better than before.”*

However, the use of technology in online learning was not always felt to benefit the pupils. According to Teacher 1: *“...I feel that attending the class and using technology in the classroom is more beneficial because the pupils are in front of me, which is better than online teaching which depends on the mothers rather than on the teachers.”*

5.4.4.1.2 Barriers of using technology in the classroom

The teachers mentioned some barriers that prevented them from using technology in the classroom. For example, there was no internet connection in the school and most of the time the teacher provided the internet connection herself. Moreover, smartboards (interactive board) were not available in every class in all schools. Teacher 1: *“These screens are not available in all classes, they are only available in some classes, this is the problem”*

Moreover, there were no laptops or devices available in the classrooms. Teacher 2: *“We are in our classes, and we are not using technology because we do not have it, our school does not have it”*. Teacher 3: *“The devices and the internet are ours, we bring them in.”*

The teachers made some recommendations for increasing the use of technology in the classroom, such as providing smart screens in all classes and equipping some classrooms in the school with devices such as computers, laptops and tablets along with an internet connection and allowing pupils to go there at least once a week. This would encourage the pupils and give them an incentive to learn as well as helping the teachers to be more creative and increase their desire to use the devices to deliver information, save time and effort. Teacher 3: *“We are in 2020 and supposed to have smart screens in all classes. I tried one, and it saves time and effort”*.

5.4.4.2 Arabic language teaching

5.4.4.2.1 Curriculum advantages and disadvantages

Teachers believe that the curriculum was a rich one and helped students to learn. Teacher 1: *“The curriculum helps 90% of the pupils to learn [effectively], and I can see the difference in the level of the pupils in the middle of the year and the end of the year from the beginning of the year. Most of the children who do not know how to read become 90% fluent by the end of the year”*.

Most teachers believed that the Arabic language curriculum was suitable for pupils of that age (7-8 years) and met their needs. One teacher mentioned that the text book required pupils to have a good level of intelligence, a supportive family and the motivation to complete the homework immediately.

The curriculum had some limitations from the teachers' point of view. Teacher 1 criticized the textbook, saying it required more pictures to enrich the lesson and deliver the information: *“The teachers, through their own efforts, present pictures or animated stories related to the curriculum at the beginning or end of the class.”* On the other hand, Teacher 2 believed that the book had enough pictures and one picture was enough for the pupils: *“We don't want the pupil to be dependent on the pictures”* and she suggested that the Ministry of Education should add texts without pictures. Teacher 2 also stated that there was a lack to exercises and required a book of exercises ² to support the curriculum. She also suggested adding more expression

² In the past, the Arabic curriculum came as two books; The teaching book and the exercises book which contained intensive exercises that supported the lessons in the teaching book.

and writing to the curriculum where students would be asked to write about a specific topic every time. Teacher 2: *"We need to add curriculum for expression (...) where pupils write five or ten lines and not as now where they write only one line or two. Two lines are not sufficient. The child needs to be able to write five or ten lines. In the first term five lines would be required and ten lines in the second term"*. Teacher 3 felt that the formal textbook had intensive exercises but it lacked sufficient reading texts.

Teacher 1 suggested that the curriculum should be in more gradual stages and the topics should be connected and relevant to the children's environment: *"The curriculum is based on the unit system, and this system is boring for the children, it is better if the subjects are connected and taught gradually. The new generation gets bored with books and bored with reading (...) Some lessons could change and be related to the environment and the reality that the child is going through."*

5.4.4.2.2 Students attitude towards the Arabic class

Teacher 1 was the boys' teacher and mentioned that they got bored with reading and writing lessons, unless if she played videos or ran a competition between them, especially if they did not know how to read or write Teacher 1: *"The children are different, some of them get bored immediately from the beginning of the class, especially those who do not know how to read. [Even if] the child is very clever he will get bored if the same text is repeated several times. Students generally get bored of reading and writing, but when there is a competition between students and when the teacher adds videos and animations related to the lesson, the pupils are engaged."*

Teacher 2 motivated her students to read and compete with each other, and sent them smiley faces. Similarly, Teacher1 provided prizes for the 'winners' (pupils who read correctly). Teacher 1: *"When teaching was done in the school, the teacher used to distribute symbolic prizes to increase competition between the pupils, but now from a distance, I use emojis in chat rooms and send them hearts or stars to encourage them"*. This competition is achieved through the developed application by sharing stories on the website where pupils can comment on each other's stories and give feedback. This feature could encourage children to read correctly in order to receive positive feedback from their teachers and classmates.

5.4.4.2.3 Various strategies for teaching the curriculum

The teachers used various strategies for teaching the Arabic language curriculum such as 'the round table', 'the train of reading' and peer learning, where the pupils do not read the full text,

but only two lines. This will help students to not get bored when they reading. Also, the teachers used a reading strategy where the teacher reads the text and changes her tone based on the characters and actions in the text, for example, mimicking a man's voice, a little girl's voice etc. Their pupils enjoyed these strategies and engaged with them. However, it was difficult to use these strategies during the online learning as there is no full control over the pupils or direct physical interaction between the teacher and the pupils.

Teacher 1: *"Currently, in distance learning, there are obstacles to using these strategies because the children are not in front of me, and it is also difficult to make them all open their microphones at the same time. However, I used the train strategy to read and divided the pupils into groups (...) Then I could ask the second group: "What do you think of the reading by the first group? What were the mistakes they made?" and so on"*

When the teachers introduce new vocabulary, they used many ways to simplify the meaning of the word, such as putting them into a sentence or multiple sentences, relating them to the surrounding environment and asking a pupil to explain the meaning to their peers. Teacher 1: *"For example, when I asked my pupils about the word 'throw', they did not know its meaning, but when I put it in the phrase "my little brother throws the cubes" and then I asked them what my little brother did, and they answered using a similar word in their dialect, so then I could explain the exact linguistic meaning of the formal word which is 'to scatter'".*

Moreover, analysing the text by extracting the linguistic features is another way that teachers used for introducing new vocabulary and helping students to learn. Teacher 2: *"During the explanation of the lesson, we grab the text and analyse it from the beginning word by word. The first thing we ask is how to explain the general meaning and discuss the general meaning of the text and then return to the text again from the first word, to see what are the phenomena contained"*

Explaining the meaning of the new words and then finding the antonyms and the opposite meaning of the new word was another strategy. Teacher 2: *"Before looking at the antonym, we look first for the meaning, because if a child does not understand the meaning of a word it is not possible to find the antonym, but it is possible to find the antonym if the meaning of the word is understood".*

If their pupils had difficulties in pronouncing or reading a word, one teacher would divide the word into small parts. Teacher 1: *"In reading the word, the pupil spells and divides the word into several parts, and then reads it completely and quickly. If he encounters difficulty with*

that, the teacher can intervene to help him and then choose another pupil to read it and then return to the student who had difficulty and made him repeat the word after his classmate. Sometimes I give him the first letter of the word to make it easier. For example, the word 'cute', I read the first two letters 'cu' and directly the pupil can complete the word and read it out."

5.4.4.3 The use of storytelling in the class

5.4.4.3.1 Mixed use

All the teachers used storytelling in class; and they showed stories from YouTube videos on the smartboard screen. Sometimes the teachers performed the stories, changing their tone of voice based on the characters and actions in the story. They also asked their pupils questions about the stories read to them. Teacher 2 created a story with 3 main characters, and always started her classes with these stories: *"We always start our lessons with stories about Makki, Zarifa, and their mother. (...) Makki is a third-year pupil and Zarifa is in the second year (...) and she asks for help from her brother who is older than her, because most of my girls have sisters in the third grade or older. (...) [The stories show that Zarifa's] brother can bring her a solution to her problems. He helps her because he is older than her by a year, so he has studied all the lessons and can be her assistant. Our story always revolves around these three characters. For example, Makki helps Zarifa learn the meaning of a sentence or mathematical operations; or Zarifa tells her mother that she is confused, for example, [about] coming up with the plural of the word 'Muslim'. [Then] her brother will come to her and say, "I will help you, my sister, Zarifa. All you need to do is to add 's' at the end of 'Muslim' to make 'Muslims'" and so on".*

5.4.4.3.2 The Benefits of using storytelling in the class

All the teachers used storytelling to support their lessons, to teach the children good behaviour or to establish a good principle through reading stories about influential people. Teacher 1: *"It is important for children to listen to stories in school, because for a child the teacher is considered to be right and other people wrong, and some children prefer the teacher's opinion over that of their parents. The teacher usually reads stories with values and information that will be firmly established in the pupil's soul (...) I read stories about correct behaviour and behaviour to be avoided. Sometimes I mention stories about influential personalities and role models such as the Prophet Mohammed (Peace be upon him). In addition, I try to make the children appreciate his character, for example of how the Prophet Mohammed (Peace be upon him), used to deal with servants and vulnerable people, and this will affect the child's behaviour and instil beautiful values."*

Moreover, teachers used storytelling to calm children down, because they enjoyed listening to the stories. Teacher 1 (boys' teacher): *"I notice that the children become calm when I tell them we will listen to a story"*.

There were many other reasons for using storytelling in the classroom. Generally, a story attracts children's attention whether it is a cartoon video from YouTube, or a story performed by the teacher. Teacher 1: *"The child, in general, is attracted by the story, especially if it has pictures or animations, something that is seen and heard."*

Teacher 2: *"The narration style and the teacher's reading play an important role, and I notice when there is a change in the voice, facial expression and movements of the hands, children engage and interact with the story. There are children who mimic the teacher's movements afterwards in reading the story."* Teacher 3: *"They are attracted to stories; it depends on how you read the story and present it. If the story is presented as a dialogue, it will attract the children's attention, but if you read the story as if you are reading an article! No"*.

Moreover, teachers used storytelling in the activity session³ and one teacher ran a storytelling competition where pupils brought their own stories from home to read in front of their classmates and then discuss it together.

Teacher 2: *"I encourage pupils to read stories from outside the curriculum and not those limited to the curriculum only. However, before reading the story, as a teacher, I have to read the story first, because there are special stories for adults and stories that violate morality, and not every story is suitable for children to read."*

5.4.4.4 The use of the application

5.4.4.4.1 Advantages of the application

Teachers liked the application, they believe that it was appropriate and suitable for pupils aged 7 to 8 and took into consideration the individual differences of pupils and their preferred learning styles as it contained pictures, sounds and texts. Teacher 1: *"The application takes into account individual differences, and the application meets pupils' needs, especially with pictures and sounds, creating a story, and also recording their voices when reading the story (...) there are pictures and sounds with words, sentences and stories. Also, they can create multiple and different stories by themselves, and there is flexibility to change stories"*.

³ This session is once a week where pupils play together.

Progress is gradual because the application starts with words, then sentences with two words, then 3, 4 and 5 words. Children can create stories with questioning at the novice level, and with no questioning at the expert level and then share their stories on the website and also write comments about each other's stories and see each other's comments. This gradual progress feature is seen as essential in early years education. Teacher 2: *"The gradual progress feature is beautiful, necessary and essential especially at this age"*.

Teacher 3: *"Supporting the child's progress in gradients starting with words then sentences, then creating a story, motivates the child at this age to read more."*

The app would support the curriculum in an interactive way and help pupils in their learning process because it contains words with particular linguistic and grammatical features. Teacher 2: *"This application is considered complementary to the curriculum (...) It will help the pupil to connect the sentences together because in the stories in the application there are letters of connection and conjunctions."*

The application made the learning process more enjoyable and it supported the idea of learning through play. Teacher 1: *"The application helps many pupils who do not like the Arabic language class and do not like reading and writing, because it presents the lessons in an entertaining way for the child by using the iPad, touching the screen, hearing sounds and viewing pictures. and this application can be considered learning through play"*.

Teacher 2: *"[The app] changes the atmosphere in the class. It depends on each teacher and how they use the application in the classroom"*.

The app can be used to learn during the class and during free time. Teacher 1: *"The application is also useful if I have free time in the class so I can use it in a fun way and for skill development as well"*. Teacher 2: *"I can allocate classes for using the application and I call it a trip with a program "Reading my story" for suspense"*. Teacher 3: *"...it will help, especially if it is used after the lesson as well as in the activity class - it is something fun and useful at the same time"*.

The app is attractive to young children who will learn from it. Teacher 1: *"I remember when you did the experiment with my pupils last year, they interacted with your app and liked it."*

The app helps children to read as it uses clear pictures that explain the texts and a read-aloud feature that helps the children to hear what they read. Children will try to mimic the system's reading which will help with fluency. Teacher 1 said the app was helpful: *"...because some children do not like reading, but the pictures help them a lot with understanding. Because most*

of the children see the picture first and then start reading the word (...) pictures and sound help to solidify the information”

The teachers saw many benefits of using the application, such as helping children unable to read by using sounds which they can try to mimic; and as a means whereby teachers can strengthen children’s fluency. Teacher 2: *“The application helps the pupil who does not know how to read, as when she hears the sentence, she will try to read it because she hears the pronunciation of the word and then returns to read it, and this helps to improve her reading. I mean, the application is excellent (...) it will help me to strengthen the weak pupils [who can] listen several times while the application reads (...) this application is very useful for late developers and weak students, because the pictures in the curriculum are not sufficient to explain the whole lesson, but all the words, sentences and stories are explained with pictures in the application”.*

Teacher 1: *“The app helped a lot of my students last year to improve their reading”.*

Moreover, the use of pictures and the read-aloud feature in the application will help children learn more independently, especially those who may not have support at home. Teacher 1: *“Some children have difficulty getting help from their family because the mother may be divorced or neglectful, so this method helps them learn without the help of anyone else (...) It gives the child self-confidence because he was able to create a story and because his classmates listened to his story while he read it, which leads to improving the level of his reading”*

In addition to that, the read-aloud feature will help correct pronunciation, especially for pupils who do not like receiving corrections from their classmates. Teacher 2: *“The app helps with the correct pronunciation and understanding of the word and how to read it”.*

Teacher 1: *“Some pupils do not like to hear their mistakes corrected by another pupil, but this method helps them to hear the word which correctly pronounced several times.”*

Creating stories with the application made the learning process more enjoyable because the children could choose their preferred elements for their own stories and they have the flexibility to change these pictures if they do not like them or they have already selected them previously.

Teacher 2: *“... the child innovates every time she tries a new story. whenever she changes the pictures in the four fields, the story will change (...) if she does not like the story that she made, she could change it by going back and switching the parts she does not like. For example, if she chose the activity ‘drawing’ and after that, she changed her mind, she could change the*

activity to 'painting'. She could change the backgrounds. She already chose the library and she doesn't like it, she could change it and choose the garden"

Creating stories is an effective way to increase the vocabulary that the pupils can read and understand, because every time they create new stories, they will read new words.

Teacher 3: *"Creating stories and the way that the stories change, based on the pupils' selection will increase their vocabulary"*.

The application will support cooperative learning, as the pupils can be divided into groups of 5 where each one selects an element of the story: The first pupil selects the background, the second selects the character, the third selects the activity, the fourth selects the emotion, and the last pupil reads the story. Also, the application can support collaborative learning when the different groups have created and shared their stories, they can be asked to comment on each group's story and compete among themselves. Teacher 1: *"It will also help in cooperative learning in the event that a number of pupils collaborate in creating a specific story, for example, I choose 5 pupils. Each one answers a question in creating the story and chooses the character, place or feelings, and one reads. Also, if one group finishes creating their story, I will ask other students from different groups "How can we add more to this story so that it becomes better?" Especially if we can display the story on the interactive screen (smartboard) and it is available for all the children to see. I also ask them which group's story was the best and this creates competition between the groups and raises motivation"*.

Moreover, creating stories as group will teach children to work in teams. Teacher 1: *"...there will be an interaction between them if they create a story as a group, and this inculcates a team spirit in them"*

Voice recording, sharing stories and viewing the shared stories from the website were believed to help the children to improve their performance and reading ability, because when they critically listened to themselves reading, they would want to correct their pronunciation and this would motivate them to try their best the next time they read.

Teacher 1: *"The pupil will improve his reading because he knows that the rest of the class will listen to him reading his own story, and this encourages him to believe in himself more. The child will tell himself that he is capable and confident"*. This could support the point that the teachers previously made about competition and rewards to motivate children to read correctly.

Teacher 2: *“The child listens to her voice after reading the story. In the beginning, her voice is not good or it is possible that she would have to spell out some words; at the second attempt, her voice has improved, and this is a nice feature [of the app] that she can listen to her voice in order to modify it. For example, at the beginning maybe she spells a difficult word like ‘antiques’ and couldn't read it well but with repetition and more attempts she will read it well, because every time she hears her voice reading the story, her performance will improve. This is a positive feature of the audio recording.”*

Teacher 2: *“When a child shares the story with her friends or sends it to anyone, she will wait for their responses and comments on the story. At first, she would read it normally, but when she listened back she would hear her voice, and then she would read it more expressively with different tones of voice based on the story's context, for instance if the story was a sad or happy one”.*

Teacher 1: *“After the pupil hears himself, he will be motivated by the fact that next time his reading will be better and be motivated to learn and try more”.*

Commenting on each other's stories on the website can enhance writing. Teacher 1: *“As for the comments on each other's stories on the website, this helps children to write and encourages them to express their opinions freely and develop the skill of criticism”.*

Moreover, teachers thought using the app could give children a sense of accomplishment when they made progress.

Teacher 1: *“A child generally likes to achieve (...) After the child has created a story with the app and earned praise from the teacher, the child will be happy with that. Also if he hears his voice while reading and creates more stories through the application, and then tell his friend that he created a story using the application, this leads to the other child's desire to use the application and create a story.”*

In addition to that, the application will enhance students' reading ability, and their writing skills, if they write down the stories they have created.

Teacher 2: *“The app enhances reading skills, and the pupil writes the story it will also enhance writing skills. This would depend on the teacher, and whether she will use the app to enhance and develop writing, or just reading”*

The app was also felt to develop children's creativity, and skills such as expression and imagination, by allowing them to create their own stories by mimicking the patterns that exist in the application. Teacher 1: *"The creation of multiple and different stories through the application has a cognitive outcome in that it helps him to create his own stories in the future by following the same method of application (choosing a character, place, feelings and activity). The child can use this, which helps him to express himself through using his imagination"*

Teacher 2 *"The app develops the child's skills by enabling her to create a story on her own in the application and then to write a story similar to the one already created, but without the helping words, and the story should be about something relevant in her environment. This will help her to write a story from her imagination and help her connect the sentences (...) The application will expand the student's imagination and train her so she can write a story from scratch and not just create a story from elements. She can practice writing the story through the story formed in the application because she can now see that writing the story will be easy and only 3 or 4 short sentences. This will also improve her expressive skills."*

The application could be used as incentive. Teacher 2: *"If we finish the main lesson, I will allocate two lessons to the application so that the girls will create a story and read it, and then write it. Or I will assign some pupils to collect information about something specific from the application such as types of exhibitions, or I will run a spelling contest We can also see who is the fastest writer in the class. They can all write their words on the board, or we can give them small boards and then display the boards on the camera on the screen."*

Teachers also thought they could benefit from the application by expanding it, and giving their pupils more information about the elements that exist in the application. Teacher 2: *"For example, with the word 'antiques', the teacher could bring some pictures about relics and ask the children where they think they are from. The teacher could also prepare a video for them about antiques to reinforce the story, and bring in pictures of antiques and information about them or she can ask them about the monuments we have in our country."*

All the teachers emphasised that they would download the app if it was available in the Apple store or the Google Play store. Teacher 1: *"As a teacher, if the application was found in the store, I would ask mothers to download it, and as a mother, I would download it for my son"*.

In terms of pupils' attitudes to Arabic language classes, the teachers felt that if the application was used, rather than just a textbook, negative attitudes would change and they would feel excited and motivated to attend.

Teacher 1: *"95% of the students enjoyed the app last year" (she referred to the pilot study) and "Their attitudes will change and improve if they can use the app instead of the monotony of only using the textbook, because the younger generation loves devices. Students will grow to love the school curriculum and will be happy to open and play with the app".*

The poor readers would be engaged and become more creative, but engagement was affected by individual differences in reading ability as the teachers expected that all pupils could read the words and sentences but that only the smart ones would be able to create the stories.

Teacher 1: *"Regarding individual differences, the application has a gradation, because it starts with words with pictures and short sentences with pictures and sounds, so most pupils will be able to read them, but when it comes to creating a story, the smarter pupils will be more able to accomplish that".*

Teacher 1: *"Last year, before using the application, some pupils were facing difficulties in reading and I expected that they would not be able to use the application and read from it due to their poor reading of the book. However, it became clear to me that when some of them opened the application they became creative and achieved even more than the others".*

5.4.4.4.2 The most positive aspects of the application

The application was appreciated as a small, light and fun application for pupils. Its clear pictures and uncomplicated words were seen as appropriate and suitable for young pupils aged around 7 to 8 years old. Its ability to guide the pupils from reading simple words and sentences to then creating stories and sharing them was considered valuable.

The application was felt to motivate pupils and encourage them to read.

Teacher 1: *"It will give them motivation and courage to read and do something new to learn"*

One of the key positive aspects of using the application is the drag and drop feature. This helps children to create their stories without writing any words. This will benefit pupils who feel bored in the traditional Arabic class because of the writing involved.

Teacher 1: *“The application does not contain writing. Some children do not like writing, so they get bored in Arabic language classes; however, the application has drag and drop pictures”.*

Moreover, the navigation restriction that prevented pupils from going to sentence level before ending the words level was seen as a nice feature.

5.4.4.4.3 The most negative aspects of the application

The need for internet connection in order to use the read-aloud features and to share the stories was perceived as one of the negative aspects of the application.

Teacher 1: *“The internet is required to hear the words and sentences, and also to share the story and record the child's voice. This is a barrier because we don't have the internet at school”.*

Moreover, creating stories could be difficult for some children. Teacher 1 expected that although most of the pupils could read the words, not all of them would be able to create stories.

Teacher 1: *“Creating a story may be difficult for some children and it takes more time to read the story, especially for students who are weak in reading”.* This point supports the findings of the three practical observations where only eleven students were able to create their stories at the expert level and then share them.

Finally, Shy pupils, or those who lack fluency, may face difficulties in voice recording when sharing their stories because they lack confidence, and their voices may be quiet when they read aloud.

Teacher 1: *“Voice recording for weak pupils who are not sure of themselves and whose voices are not loud may be difficult, and they may be unwilling to record their voices and read out long stories. Some pupils are shy when they read and hear their voices, but with encouragement, they can become confident; and the teacher plays a role in strengthening weak pupils by encouraging them, standing by and helping them.”*

This point supports the findings of the three practical observations where the researcher noticed that some ‘shy’ pupils read their stories at the expert level with quiet voices, but when they heard themselves on the shared stories website, they tried to read loudly and correctly. When the pupils progressed through the sessions, they read loudly and sounded confident when they read.

Teacher 2 suggested that this application could be also suitable to be used in the second term with the first-year pupils, after they had learnt the alphabet as it contained pictures and sounds.

5.4.4.4 Teachers' rating the applications' features out of 10

At the end of the interviews, the teachers were asked to rate the following features based on their observations of how using had affected their pupils:

- **The effectiveness of the application in improving reading skills**

All teachers rated this as 10 out of 10.

Teacher 1: *"I noticed its effectiveness with my pupils last year, especially since many had difficulty reading and were not reading in the classroom. However, with the use of the application last year, their performance improved and it has had an effect. (...) The students also asked me when you would come again because they want to use the app."*

Teacher 2: *"Most excellent and contains enriching words. If the application is available, I will download it for my daughter, because it starts with words and sentences, after which she creates a story, and then read it, and then maybe I will dictate the story that she made. A conscious mother would dictate to her daughter the story that she made"*

Teacher 3: *"This application will prepare a fast-reading child through his linguistic inventory of the many words he has seen in this application and also increases his verbal wealth."*

- **The effectiveness of this application in improving reading comprehension skills**

All teachers rated this as 10 out of 10.

Teacher 1: *"[I rate it] 10, because for reading gradually and understanding the text being read, especially when creating a story, [the app] helps a lot with comprehension, and reading [the story aloud] and recording it completes the understanding process: I read, compose and understand = achievement. As long as the child creates a story and understands it, even if it is brief, it is considered that he has achieved what he is required to do."*

Teacher 2: *"It depends on the pupil. There are individual differences, there are girls who want to write and read. The words, sentences, and stories are clear and uncomplicated, and the pictures and sounds help the pupils. If a pupil did not understand that means she did not read or she did not focus."*

Teacher 3: *“This application is gradual and starts with words and sentences then creates stories and this logical progression help students’ understanding and encourages them to read more.”*

- **The effectiveness of this application in enhancing students’ participation in Arabic language classes**

All teachers rated this as 10 out of 10.

Teacher 1: *“As a group, there will be a problem. Some children like possession and like to be in control while others are peaceful, so there may be a problem with sharing devices. But if every student has his own iPad, there will be no problem. As for sharing the story on the website and having the child hear his voice and knowing that others are hearing it enhances confidence. I am confident in myself. I can make a story and reading it enhances self-confidence”*

Teacher 2: *“There is enthusiasm and a change of atmosphere that gives them motivation and enthusiasm, because everyone will create her story and read it. But this is for those who know how to read, but those who do not know may not benefit from it. On the other hand, when a pupil hears the recording of her friends reading, she could go in two directions. She can get excited with them or she can turn away and leave them, and this may be because of her home environment and the role of the mother, who is not motivating her daughter. Education at an early age depends 95% on the home.”*

Teacher 3: *“The application is characterized by an easy and logical progression which enhances pupils' participation and understanding “*

- **The effectiveness of using reading aloud feature in enhancing students’ reading skills**

All teachers rated this as 10 out of 10.

Teacher 1: *“[I rate it]10 because the sound teaches the child the basic correct word. For example, when he sees the picture of a window, the pupil will say "طاقة" or "تسباك", but when the sound is turned on, it says "تافنة", so he knows the correct meaning, and the information is reinforced for the child if he associates words with pictures and sounds.”*

Teacher 2: *“The girl who knows how to read well may not press the read-aloud button and does not need to press it; or she may click on it for fun. But this function strengthens the weak student who sees the word and hears how to read it.”*

Teacher 3: *“It improves vocabulary and sensory perception of children from the age of 6 to 9”*

- **The effectiveness of using pictures in enhancing students’ understanding of Arabic vocabularies**

All teachers rated this as 10 out of 10.

Teacher 1: *“Many students do not know how to read. Pictures help them to know the word”*

Teacher 2: *“The pictures are very clear”*

Teacher 3: *“The pictures help [pupils] to understand what is written”.*

5.4.5 Pre and post tests results

The following section will describe the differences for each student in the pre and post tests for both the experimental and control groups in different variables.

5.4.5.1 Total time spent on reading the stories (passages) in Seconds

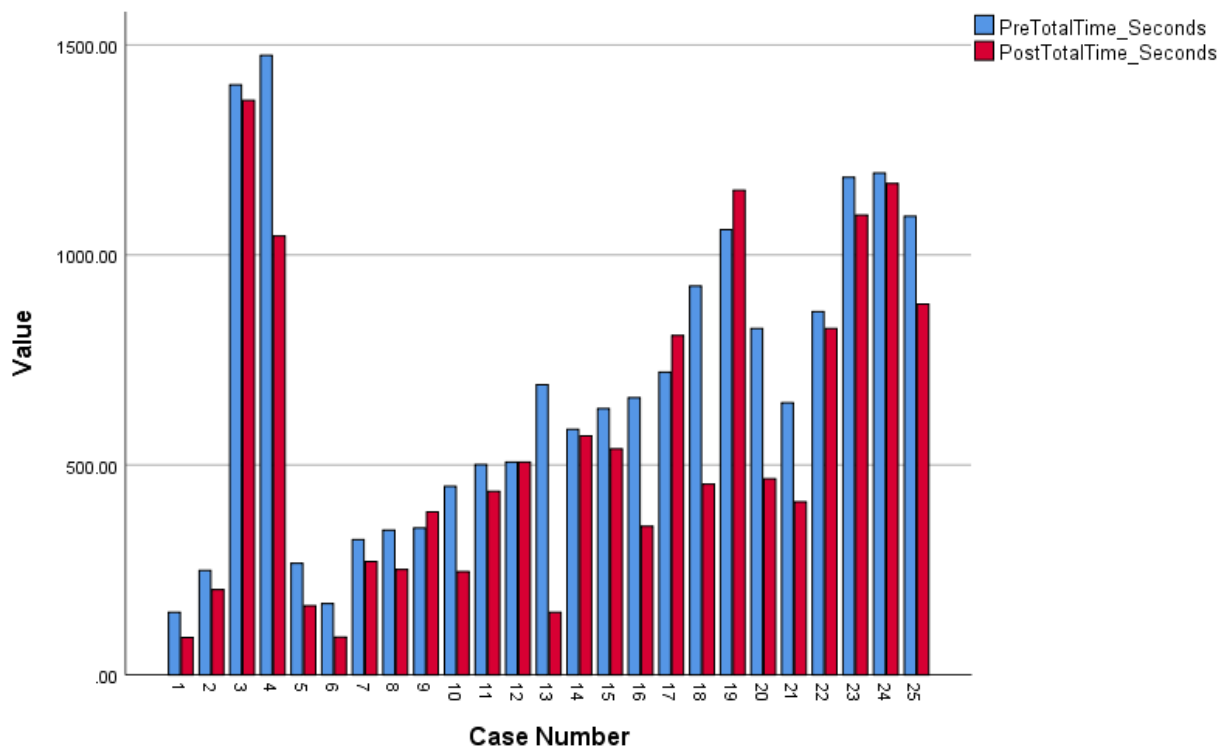


Figure 5.9: Pre and post total time in seconds for the experimental group

Figure 5.9 shows that most of the students in the experimental group (21 students) spent less time in reading the post-test than the pre-test. Three students spent more time on the post-test while one student spent the same amount of time on reading both tests. On the other hand, Figure 5.10 shows that no significant differences between the pre and post time for the control group even though there is a slight improvement on the post-test than the pre-test for almost nine students.

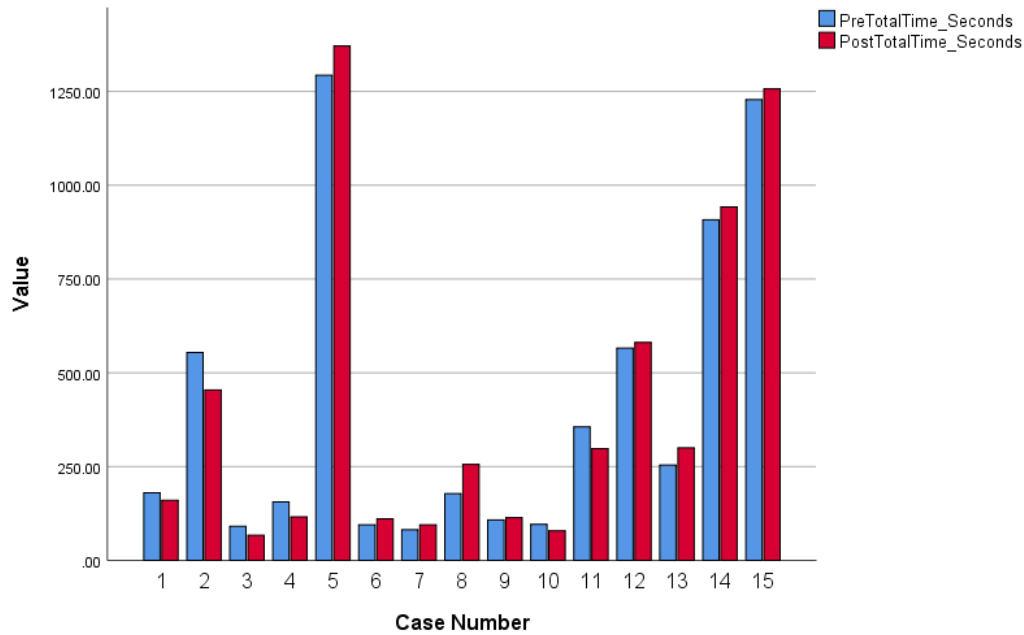


Figure 5.10: Pre and post total time in seconds for the control group

5.4.5.2 Rate

Rate is defined as the number of words read per minute with and without errors. The rate was calculated as (word per minute) for all students after 1 minute and 3 minutes of reading.

5.4.5.2.1 Rate in 1 minute

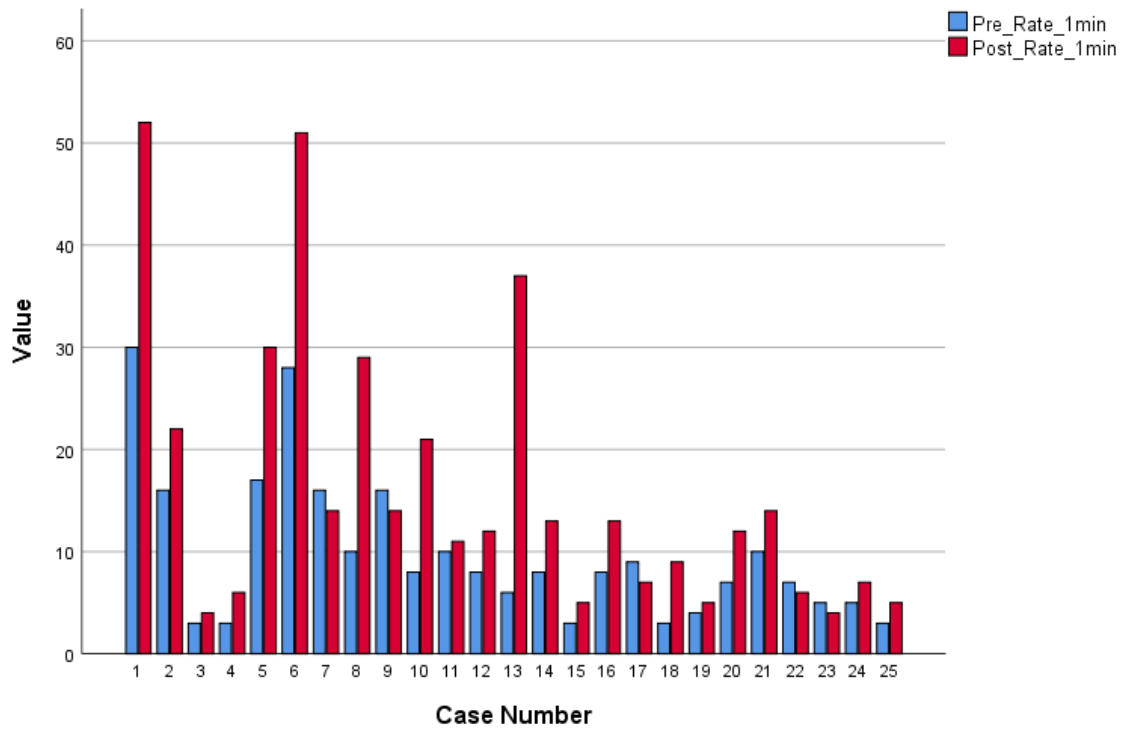


Figure 5.11: Rate at 1 minute for the experimental group

As can be seen from Figure 5.11, most of the students in the experimental group (20 students) had increased rate on the post-test compared to the pre-test. Only 5 students' rates were slightly decreased on the post-test. On the other hand, four students of the control group were doing less well on the post test, three students their rate was the same to the pre-test as in Figure 5.12. Three students their rate was slightly increased on the post-test and four students has their rate improved significantly.

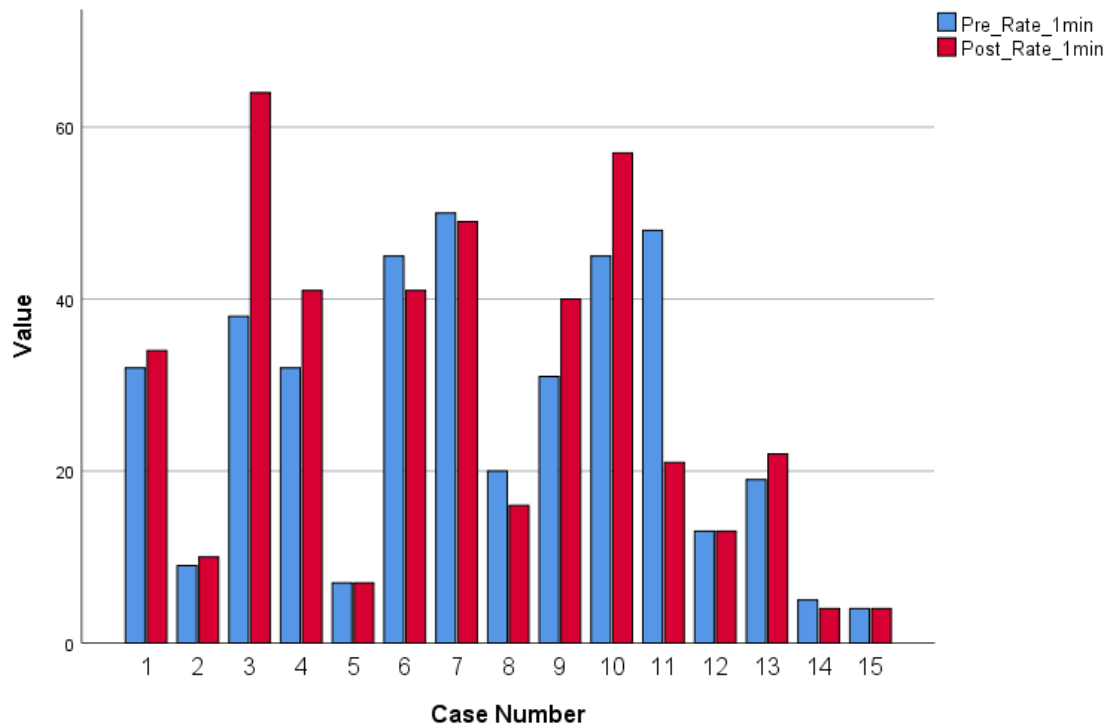


Figure 5.12: Rate at 1 minute for the control group

5.4.5.2.2 Rate in 3 minute

As shown in Figure 5.13, there was significant increase in most of the students' rates at 3 minutes of reading for the experimental group. Only three students' rates decreased on the post-test compared to their rate on the pre-test. Moreover, two students (student 10 and 13) have significantly improved on their rate in 3 minutes. On the other hand, approximately half of the student on the control group rate has slightly improved, six students their rate decreased on the post-test with respect to the pre-test and one student showed no difference between their rate on the pre and post-tests as in Figure 5.14.

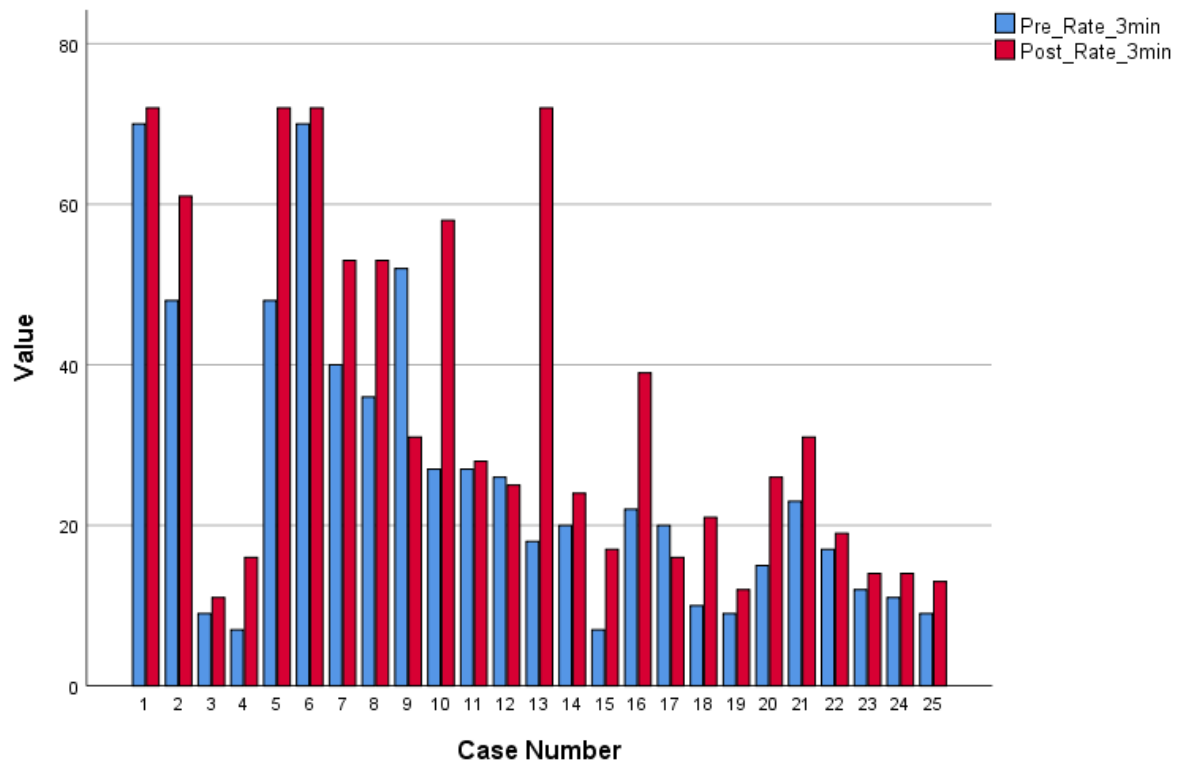


Figure 5.13: Rate at 3 minutes for the experimental group

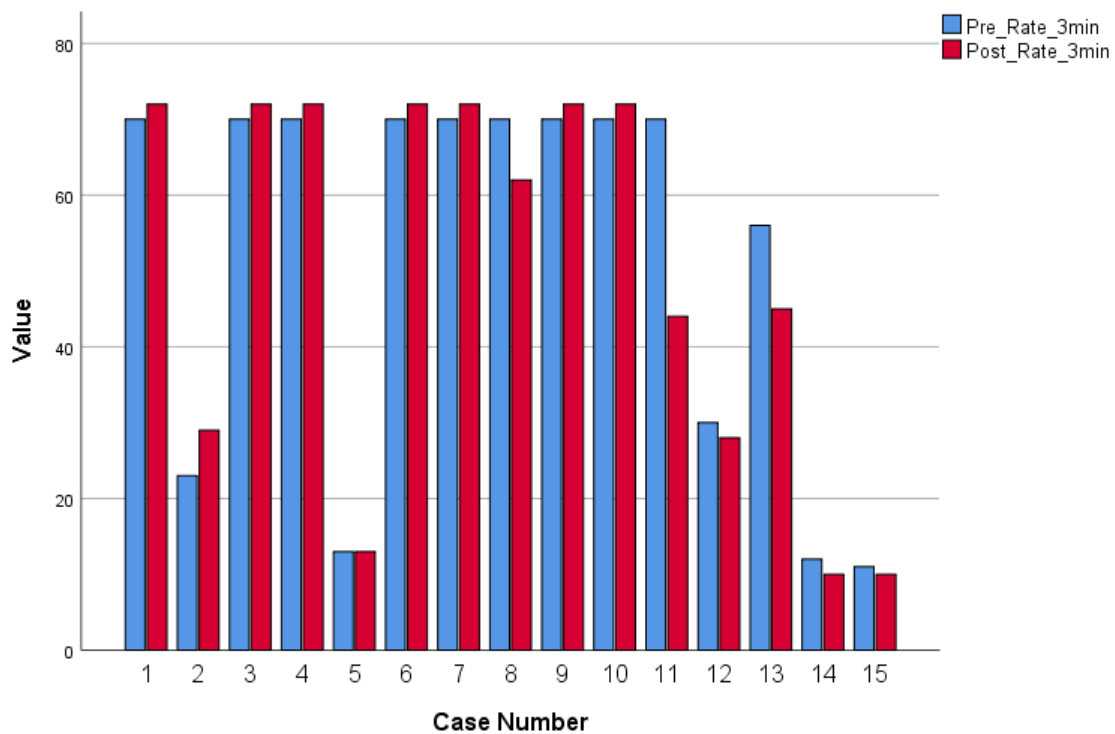


Figure 5.14: Rate at 3 minutes for the control group

5.4.5.3 Words correct per minute - WCPM

WCPM was calculated as the number of words read in one minute minus the number of errors. Here, substitutions, mispronunciations and omissions were considered as errors. Self-corrections, decoding, reading words repeatedly were not counted as errors. WCPM was scored at 1 minute and 3 minutes.

5.4.5.3.1 WCPM in 1 minute

Figure 5.15 shows that most of the students in the experimental group (19 students) improved on their WCPM on the post-test than in the pre-test, only five students who did slightly better on the pre-test and only one student who showed no difference between the pre and post-test. Moreover, one student (student 4) had not read any correct words on the pre-test while she read a few words correctly on the post-test. Figure 5.16, shows that approximately half of the students on the control group have not improved on their WCPM on the post test, one student shows no difference, and the rest show a slight improvement on their post-test.

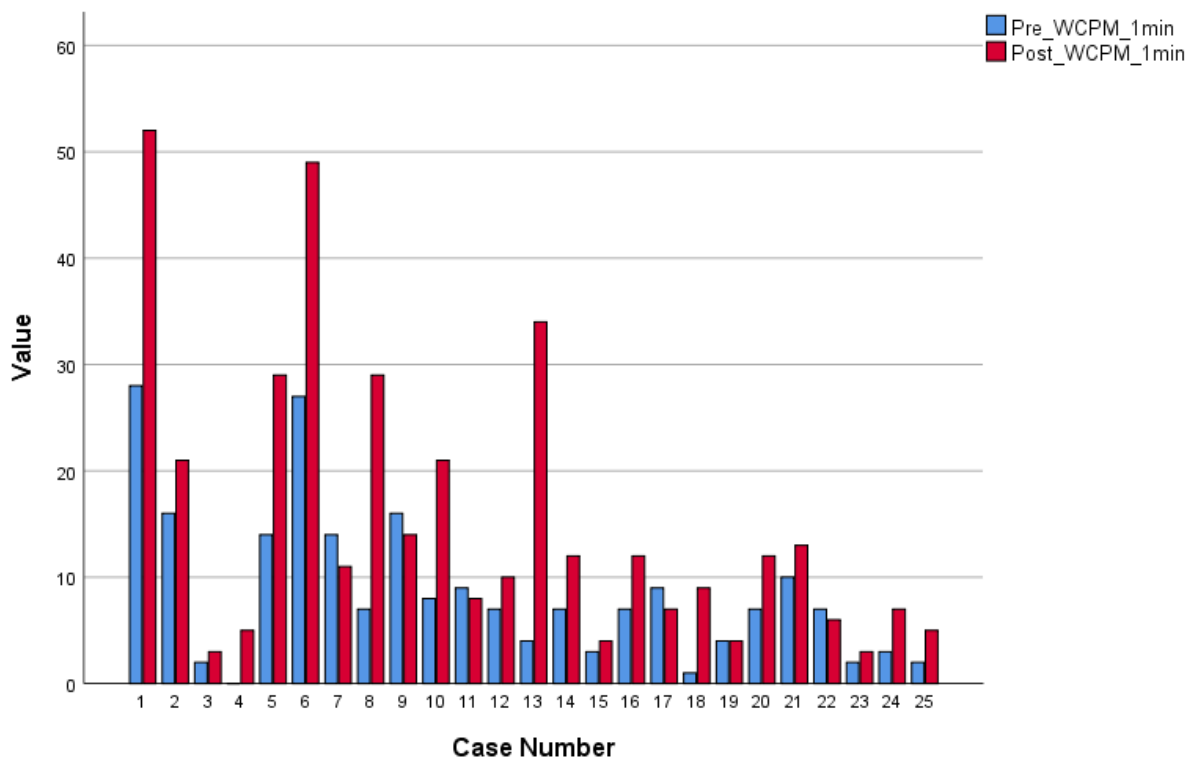


Figure 5.15: WCPM at 1 minute for the experimental group

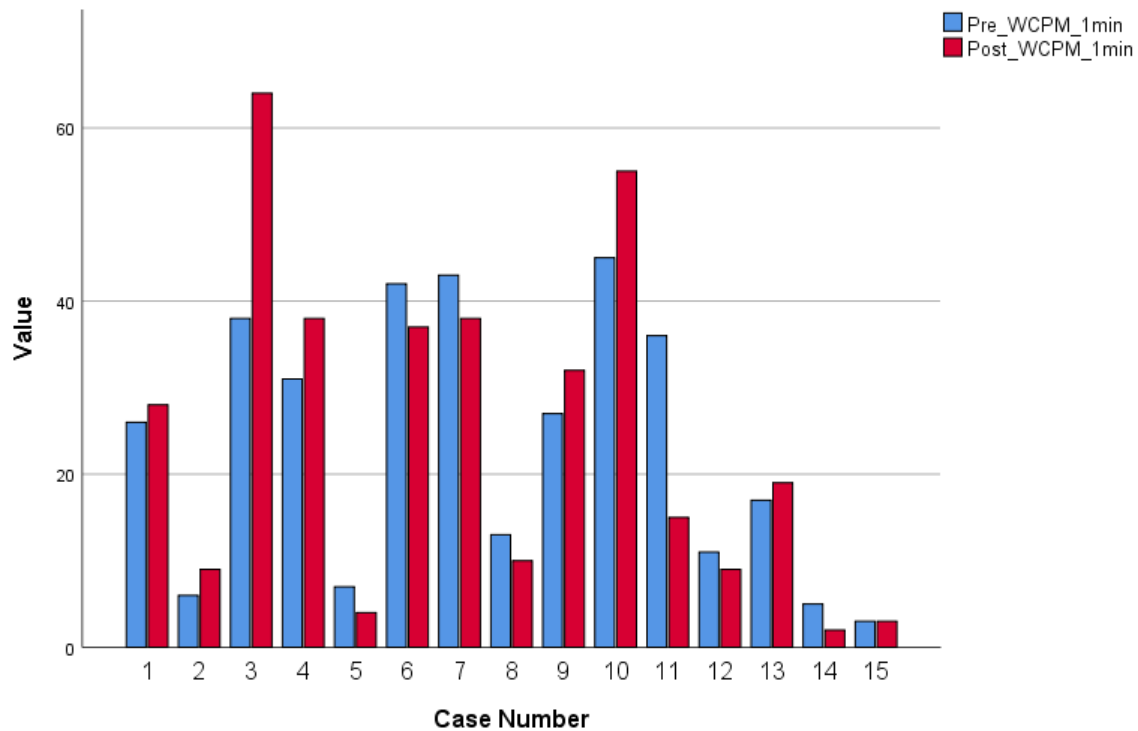


Figure 5.16: WCPM at 1 minute for the control group

5.4.5.3.2 WCPM in 3 minute

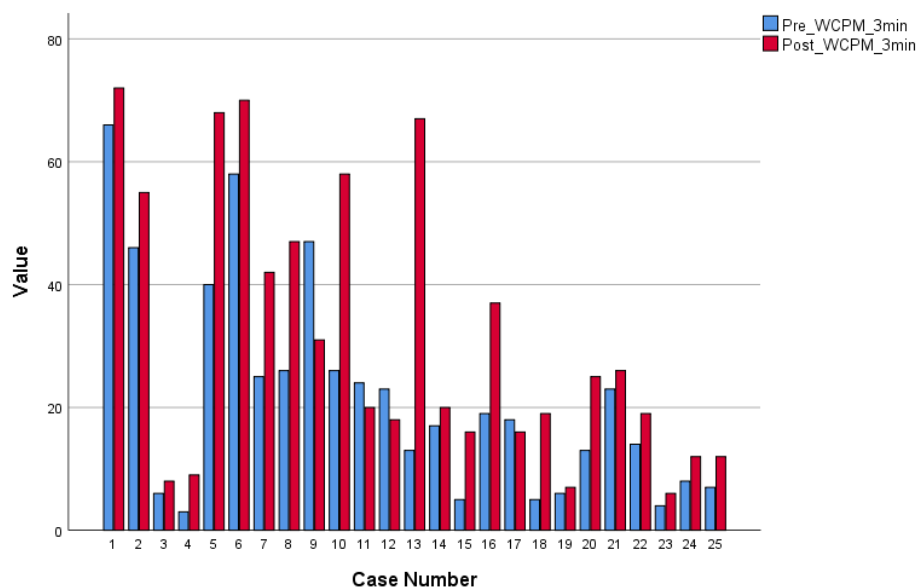


Figure 5.17: WCPM at 3 minutes for the experimental group

Figure 5.17 shows that most of the students on the experimental group significantly improved (21 students) on their WCPM on the post-test at 3 minutes except student 9,11,12 and 17. On the other hand, Figure 5.18 show no significant difference in the control group between their

pre and post-test with approximately half of the student doing better on the pre-test rather than the post-test.

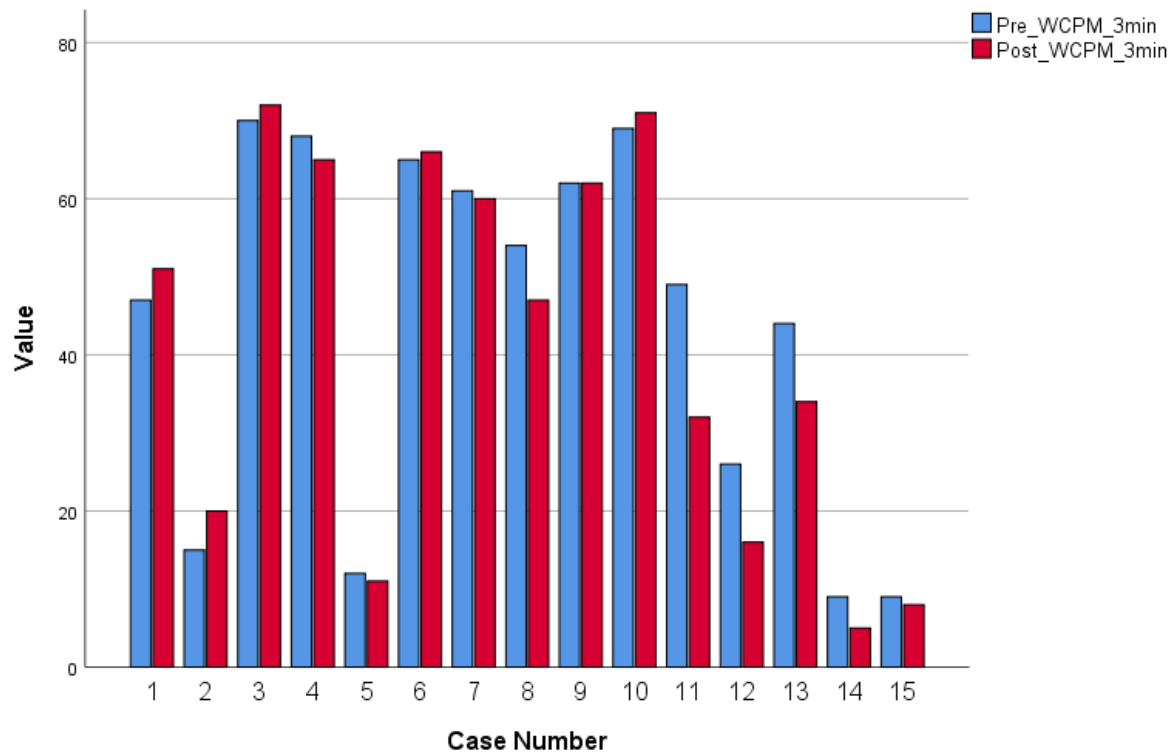


Figure 5.18: WCPM at 3 minutes for the control group

5.4.5.4 Accuracy

Accuracy of reading was calculated as the percentage by dividing the number of words read correctly per minute (WCPM) by the total number of words read per minute. The accuracy was calculated at 1 minute and 3 minutes.

5.4.5.4.1 Accuracy at 1 minute

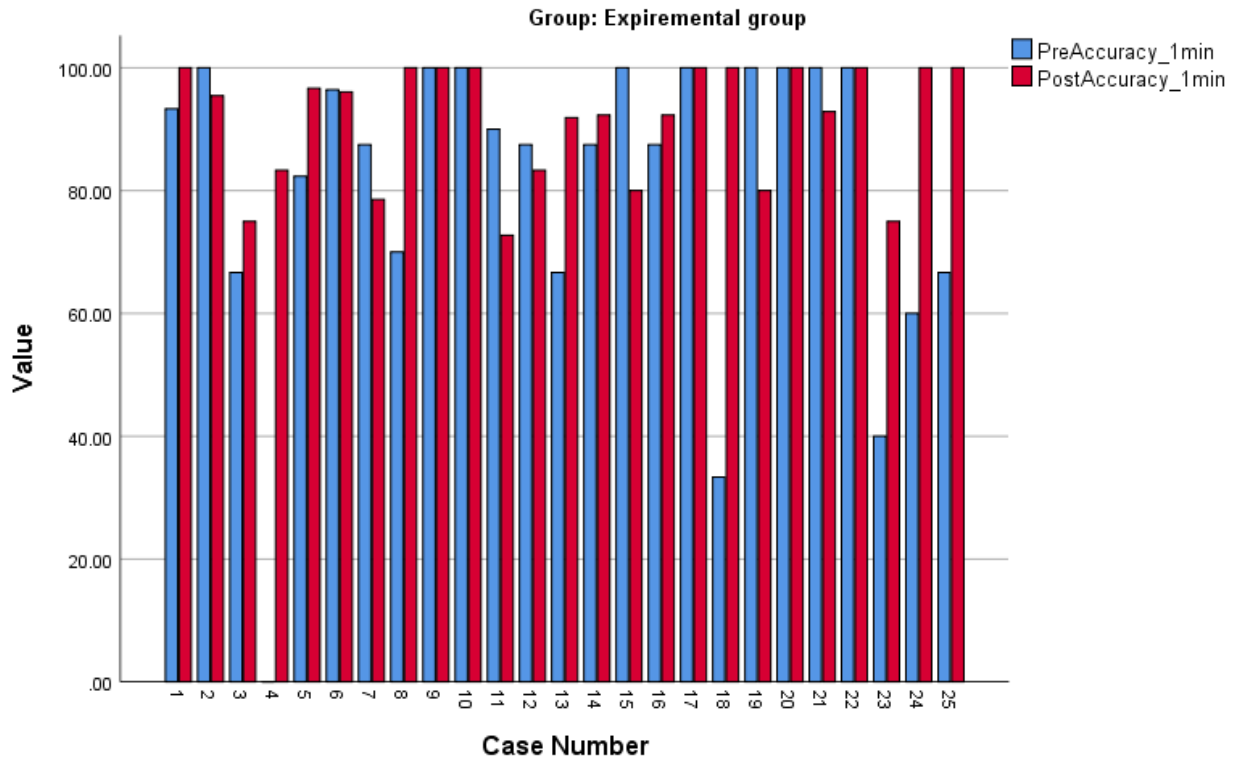


Figure 5.19: Accuracy at 1 minute for the experimental group

Figure 5.19 shows that approximately half of the students (12 students) in the experimental group have significantly increased their accuracy and the ability of reading correctly on the post-test than the pre-test. As can be seen, student 4 had not read any correct word per minute on the pre-test while she read some words correctly on the post test. Only seven students who did better on the pre-test than the post test. Students 9,10,17,20 and 22 show no difference in their accuracy between the pre and the post tests. However, most of the control group students did better on their pre-test than their post-tests. Students 3 and 15 show no difference in their tests. Only 2 students who slightly did better on the post-test as in Figure 5.20.

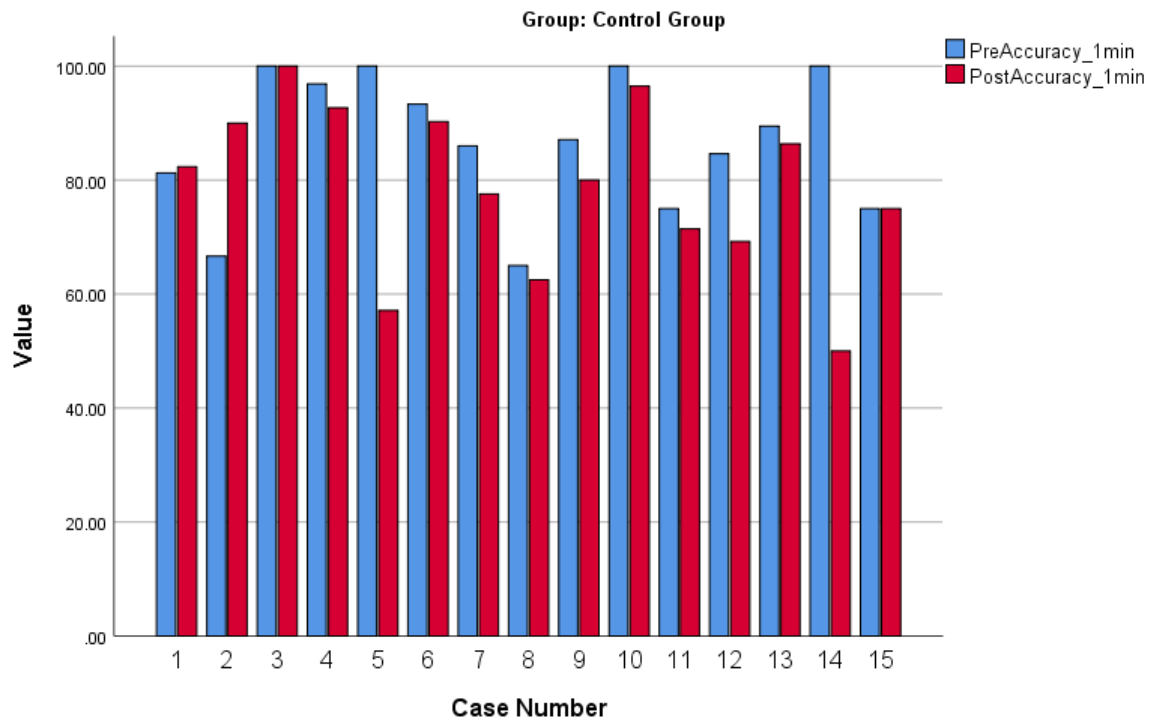


Figure 5.20: Accuracy at 1 minute for the control group

5.4.5.4.2 Accuracy in 3 minute

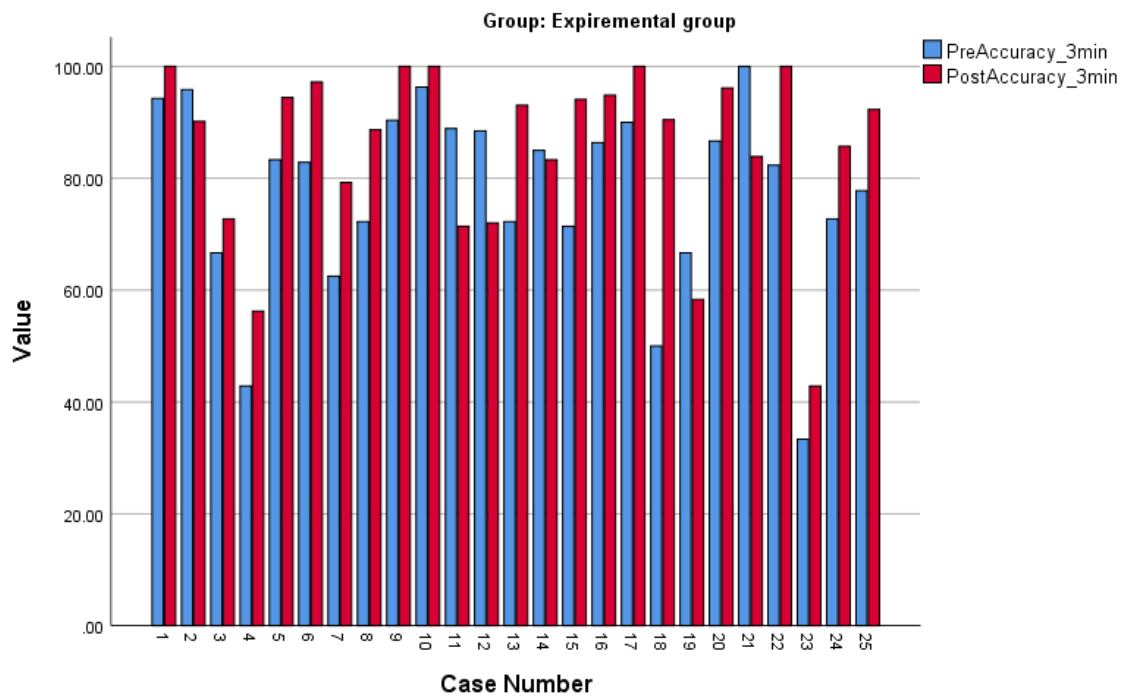


Figure 5.21: Accuracy at 3 minutes for the experimental group

Figure 5.21 shows that most of the students in the experimental group (19 students) have significantly increased their ability of reading accurately on the post-test than the pre-test. As can be seen, only six students who did better on the pre-test than the post test. However, the control group students mostly did better on their pre-test than their post-tests. Students 3 and 10 show no difference in their tests. Only 3 students who slightly did slightly better on the post-test as in Figure 5.22.

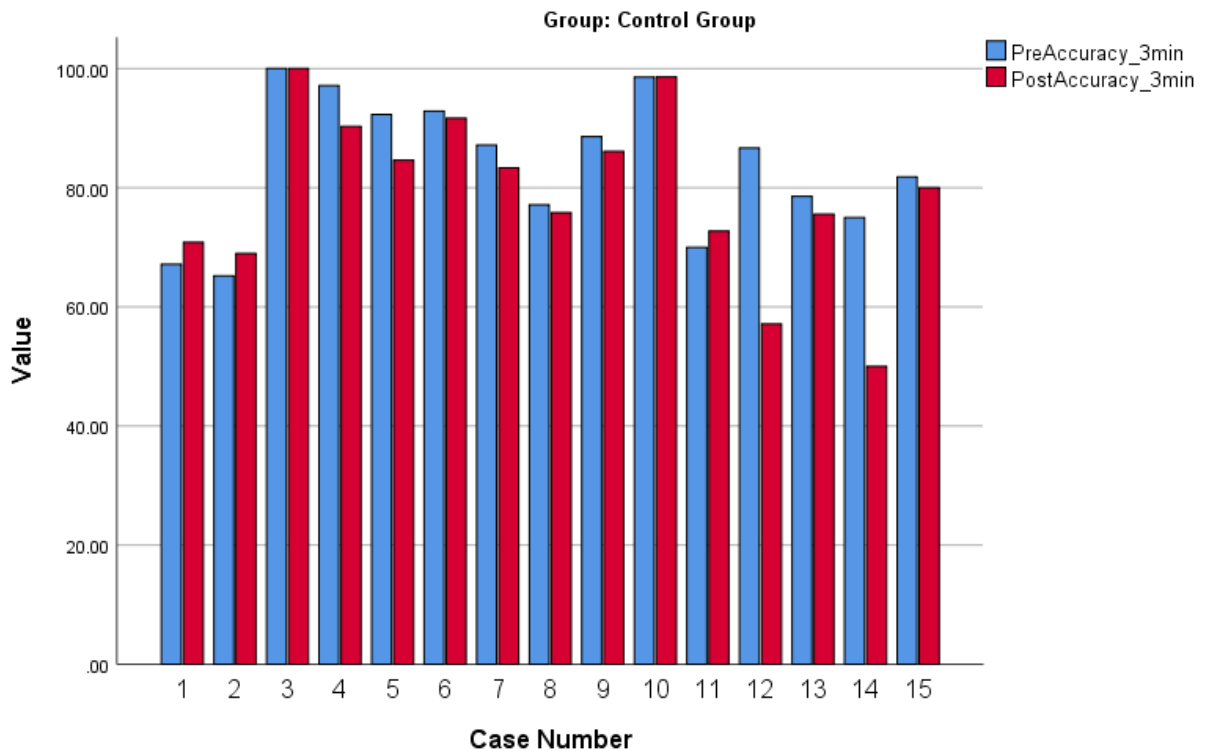


Figure 5.22: Accuracy at 3 minutes for the control group

5.4.5.5 Comprehension

To obtain the comprehension score, students answered orally five questions associated with the reading passage. The researcher read each question. Students receive a 0 for an incorrect response or no answer, a 1 for a partially correct response i.e. If incorrect information was included along with the correct response, a 2 for each correct answer. Questions forms could include who, what, where, why, and how questions.

5.4.5.5.1 Right Answers

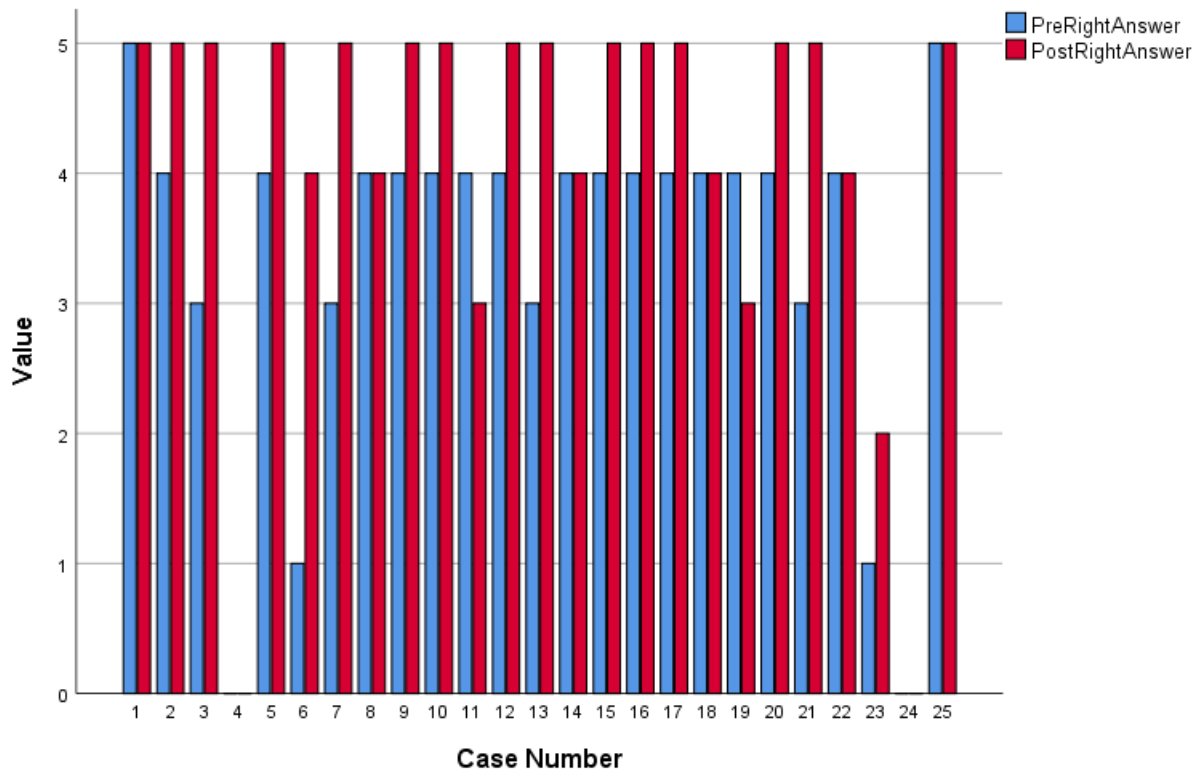


Figure 5.23: Comprehension right answers for the experimental group

As can be seen from Figure 5.23, most of the experimental group students (15 students) have improved on their comprehension by giving more right answers on the post-test than the pre-test. Only two students answered more right answers on the pre-test than the post-test. Six students show no difference between the pre and post-test. Two students had no right answers on both the pre and post-test.

However, Figure 5.24 shows that seven students of the control group show no difference between the pre and post-test. Three students had answered some pre-test questions correctly more than their post-test. Only five students who show an improvement on their post-test.

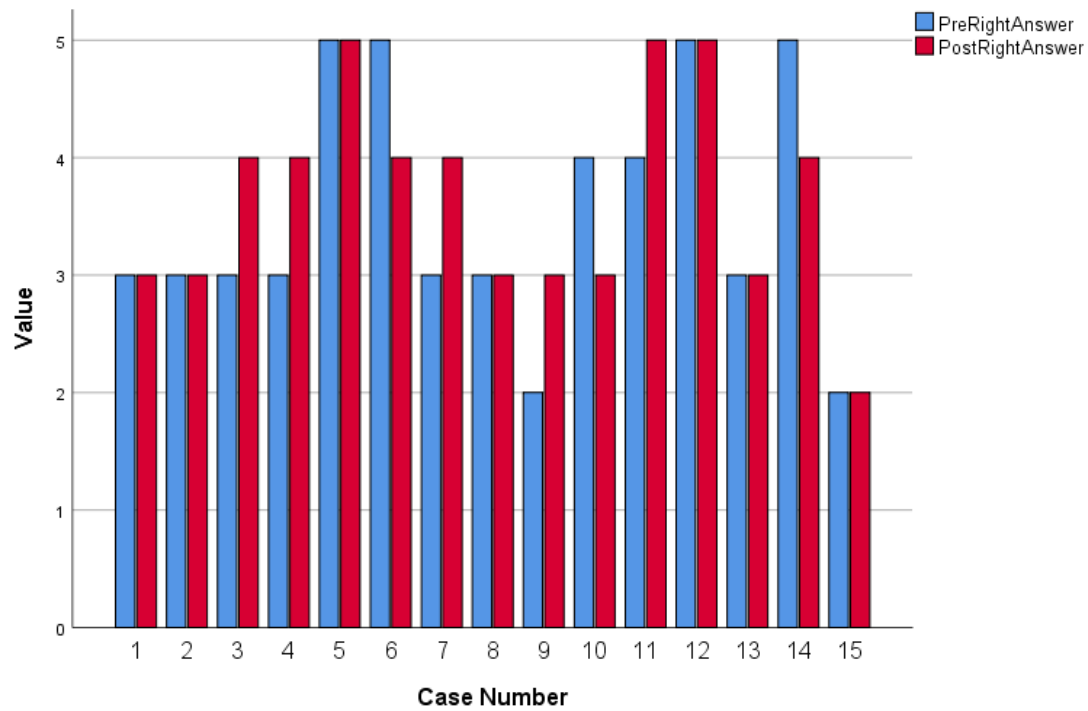


Figure 5.24: Comprehension right answers for the control group

5.4.5.5.2 Wrong Answers

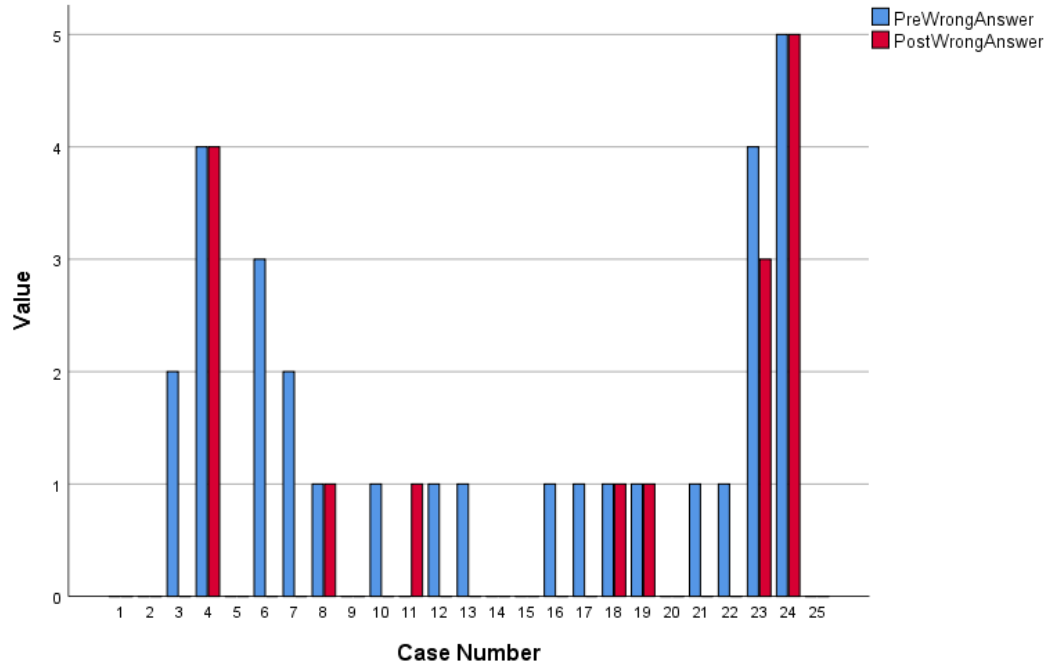


Figure 5.25: Comprehension wrong answers for the experimental group

Figure 5.25 shows that most of the experimental group responded wrongly to some of the pre test questions while most of them show no wrong answers on their post tests. Five students showed no difference on their answers on the pre and post tests.

However, four of the control group students had made wrong answers on the pre test. Five students had no wrong answers on both the pre and post tests. Four students showed no difference on their answers on the pre and post tests. Only two students who has increased their wrong answers on the post test as in Figure 5.26.

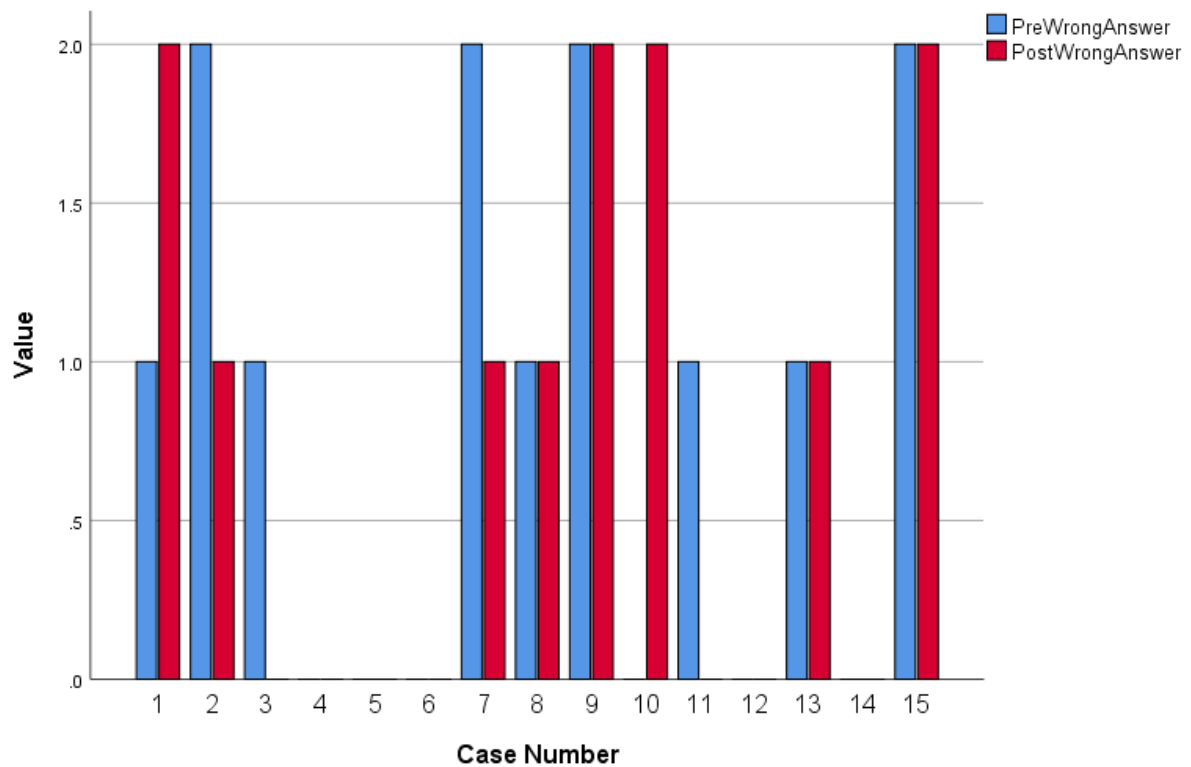


Figure 5.26: Comprehension wrong answers for the control group

5.4.5.5.3 Half Answers

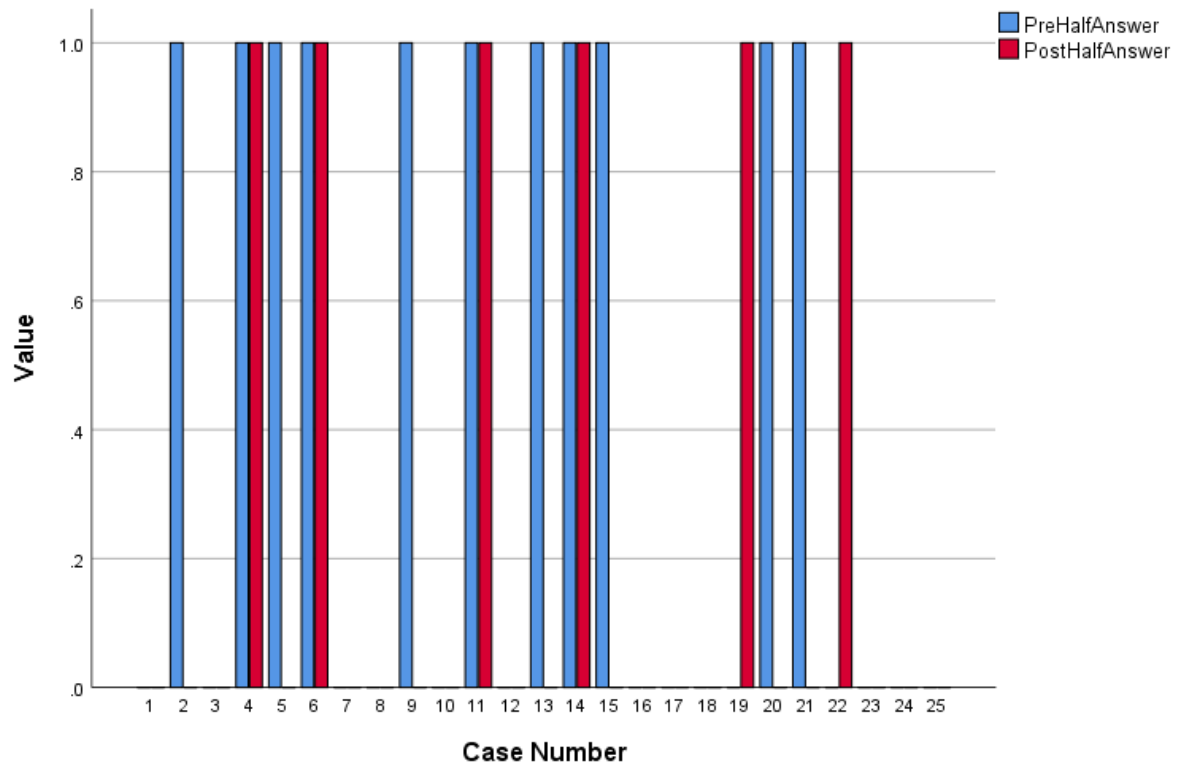


Figure 5.27: Comprehension half answers for the experimental group

Figure 5.27 shows that twelve students on the experimental group have no half answers on their pre and post-tests, six students had made half answers on the pre-test while two students on the post-test and four students show no difference on their pre and post-test. However, four students on the control group show no half answers on their pre and post-test, four students made more half answers on the pre while three students on the post, and four students show no difference on their pre and post-tests as in Figure 5.28.

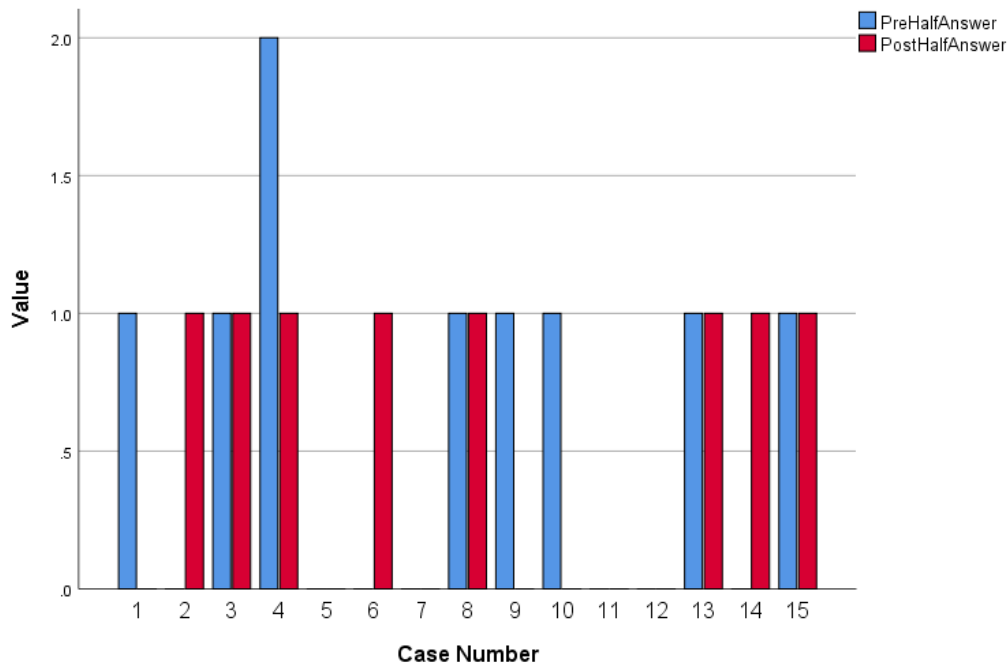


Figure 5.28: Comprehension half answers for the control group

5.4.5.6 Total Right and wrong words

Here, the total right words and total wrong words read by students on the both pre and post-tests were measured.

5.4.5.6.1 Total right words

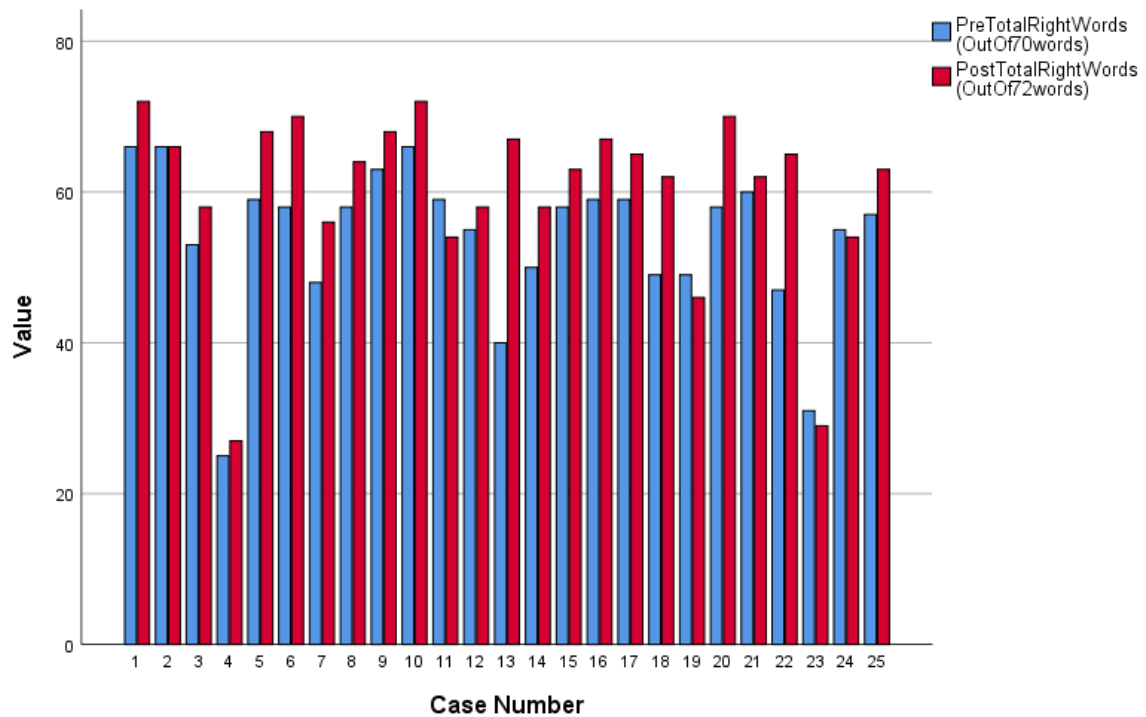


Figure 5.29: Total right words for the experimental group

Figure 5.29 shows that most of the experimental group (20 students) have increased significantly on their reading for the right words on the post test. Only four students show a slight decreased on the reading the right words on the post tests and one student show no difference between the pre and post-test. However, approximately half students of the control group show a slight decrease on the reading the right words on the post-test and six show a slight increase on the reading the right words on the post tests and three students show no difference between the pre and post-test as in Figure 5.30.

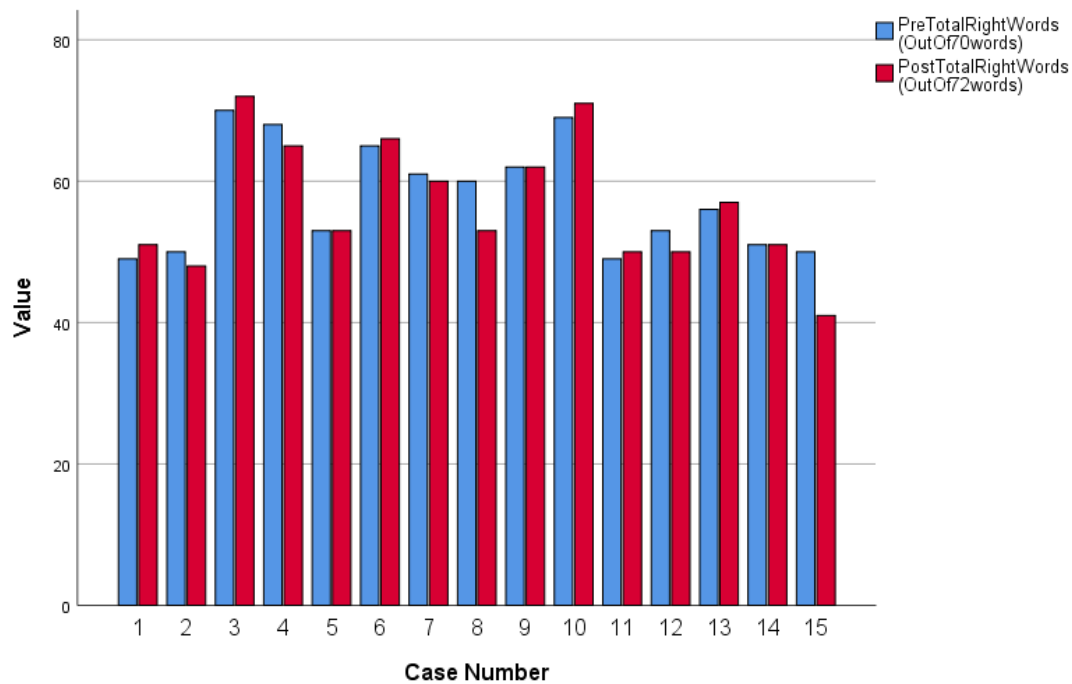


Figure 5.30: Total right words for the control group

5.4.5.6.2 Total wrong Words

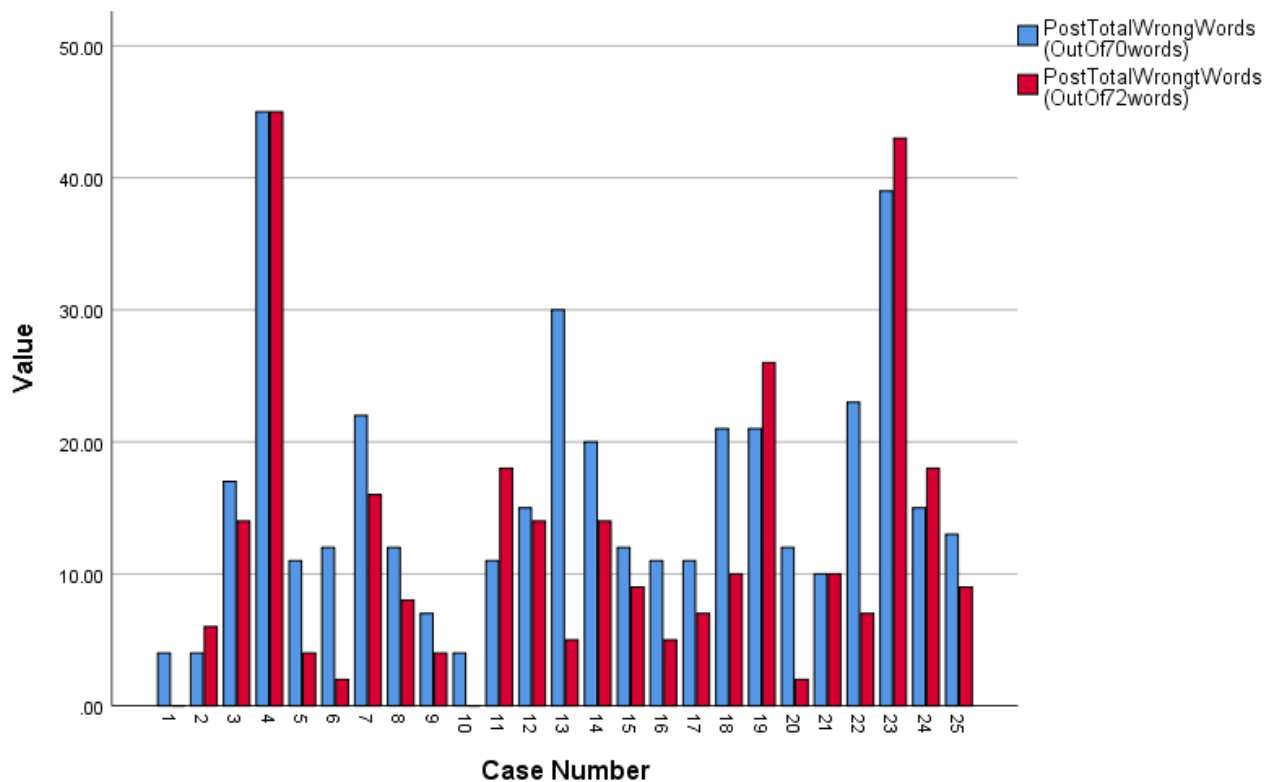


Figure 5.31: Total wrong words for the experimental group

As can be seen in Figure 5.31 show that most of the experimental group (18 students) had a significant decrease on reading wrong words on the post-test than the pre-test. Two students had read wrong words on the pre-test with no mistakes on the post while two students had no difference between the pre and post-test. Figure 5.32, shows that most of the control group students had made more mistakes on the post-test. Only one student who had not made any mistake on both tests and one student had no difference between the pre and post-test.

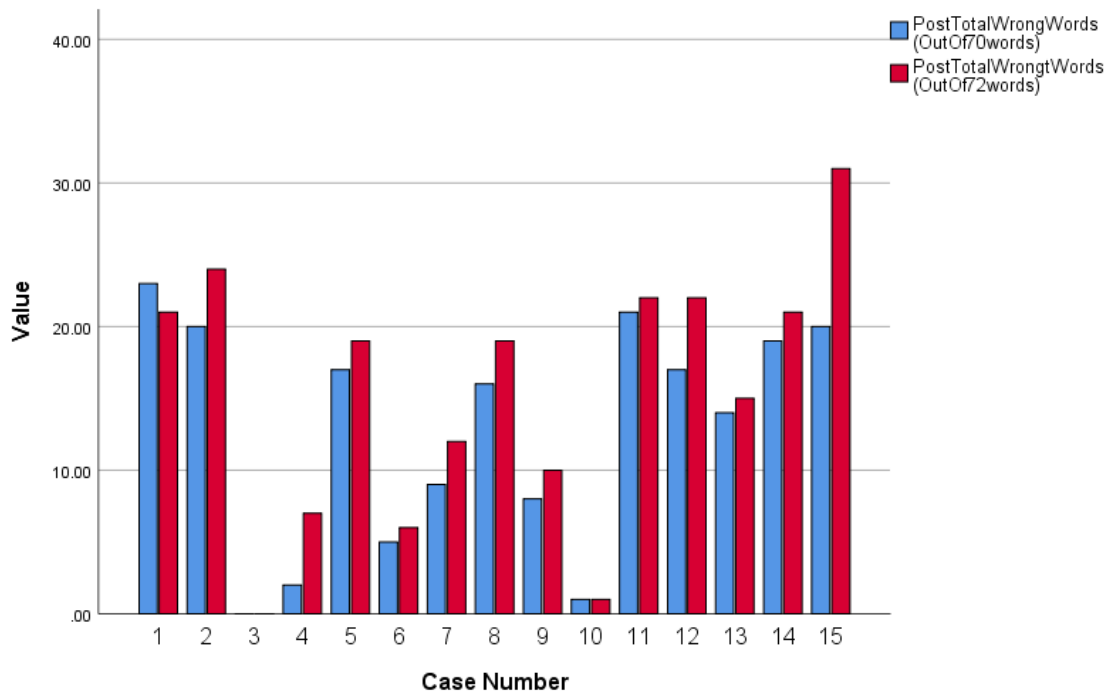


Figure 5.32: Total wrong words for the control group

5.4.6 Repeated Measures t-test: Paired Samples t-test

5.4.6.1 Rate

A repeated measures t-test was used to examine whether or not there is a significant difference between participants in the pre and post-tests. This was conducted for all Rate variables, it was apparent that there is a significant difference ($t=3.92$, $p<0.01$) between the two tests, participants in post-test ($M= 557.48$, $SD=378.63$), showed significant improvement compared to the pre-test in total time spent reading ($M= 691.0$, $SD=380.95$). This indicates that the system has led to a significant improvement in reading time.

For the second variable, rate per minute, there was also a significant difference ($t=-3.629$, $p<0.01$), participants scores in the post-test ($M=16.12$, $SD=13.74$) was significantly better than participants' scores in the pre-test ($M= 9.72$, $SD=7.24$). This indicates that the system has led to a significant improvement in rate per 1 minute.

For the third variable, rate per 3 minutes, there was also a significant difference ($t=-3.092$, $p<0.01$), participants scores in the post-test ($M=34.80$, $SD=22.07$) was significantly better than participants' scores in the pre-test ($M= 23.32$, $SD=17.08$). This indicates that the system has led to a significant improvement in rate per 3 minutes.

Table 5.12. Descriptive and paired samples t-test outcomes for the experimental and control group and Rate Variables

Group	Variable	Pretest	Posttest	Paired samples t-test	
		Mean/SD	Mean/SD	t-value	Significance (p)
Exp.	Total time (sec.)	691.0/380.95	557.48/378.63	3.922	0.000
	Rate in 1 min	9.72/7.24	16.12/13.74	-3.629	0.001
	Rate in 3 min	26.12/18.756	34.80/22.07	-3.168	0.004
Control	Total time (sec.)	409.66/417.36	413.40/435.53	-0.297	0.770
	Rate in 1 min	26.53/ 16.57	28.20/ 19.75	-0.582	0.569
	Rate in 3 min	51.66/ 25.43	49.66/ 25.47	0.980	0.343

For the control, no significant differences were noted between the two tests for all the three variables Total reading time, rate per minute and rate per 3 minutes.

5.4.6.2WCPM

It is clearly appears that that there is a significant difference ($t = -3.646$, $p < 0.01$) between the two tests, participants in post-test ($M = 15.200$, $SD = 13.610$), showed significant improvement compared to the pre-test in Word correct per minute ($M = 8.5600$, $SD = 7.269$). WCPM at 3 minutes, shows a significant difference ($t = -3.414$, $p < 0.01$) appearing between the two tests. This indicates that the system has led to a significant improvement in students WCPM at 1 minute and at 3 minutes.

Table 5.13. Descriptive and paired samples t-test outcomes for the experimental and control group and WCPM Variables

Group	Variable	Pre	Post	Paired samples t-test	
		Mean/SD	Mean/SD	t-value	Significance (p)
Exp	WCPM in 1 min	8.56/7.26	15.200/13.61	-3.646	0.001
	WCPM in 3 min	21.68/17.40	31.20/22.10	-3.414	0.002
Control	WCPM in 1 min	23.33/ 15.29	24.20/ 19.41	-0.338	-0.740
	WCPM in 3 min	44.00/ 23.45	41.33/ 24.61	1.712	0.108

For the control, no significant differences were noted between the two tests for WCPM per minute and per 3 minutes.

5.4.6.3 Accuracy

For the Accuracy at 1 min variable, it was apparent that there is a significant difference ($t = -2.120$, $p < 0.05$) between the two tests for the experimental group, participants in post-test ($M = 91.42$, $SD = 9.68$), showed significant improvement compared to the pre-test in Accuracy at 1 minute ($M = 80.61$, $SD = 25.47$). Similarly, for the Accuracy at 3 min variable shows a significant difference ($t = -2.982$, $p < 0.01$) between the two tests, participants in post-test ($M = 85.49$, $SD = 15.41$), showed significant improvement compared to the pre-test ($M = 77.56$, $SD = 16.87$). This indicates that the system has led to a significant improvement in student reading accuracy. This means that the system could help the student in reducing their errors and increase their ability to read correctly.

Table 5.14. Descriptive and paired samples t-test outcomes for the experimental and control group and Accuracy in 1 minute and 3 minutes

Group	Variable	Pretest		Posttest		Paired samples t-test	
		Mean	SD	Mean	SD	t-value	Significance (p)
Experimental group	Accuracy in 1 min	80.61	25.47	91.42	9.68	-2.120	0.045
	Accuracy in 3 min	77.56	16.87	85.49	15.41	-2.982	0.006
Control Group	Accuracy in 1 min	86.68	12.08	78.73	14.66	1.745	0.103
	Accuracy in 3 min	83.87	11.40	79.04	14.04	1.925	0.075

For the control, no significant differences were noted between the two tests for Accuracy over 1 minute and 3 minutes.

5.4.6.4 Comprehension

The results indicates that there is a significant differences in the experimental group in comprehension variables Total right answers ($t=-3.919$, $p<0.01$) and total wrong answers ($t=3.218$, $p<0.01$) for the post-test ($M= 4.12$, $SD=1.48$) and ($M= 0.64$, $SD=1.35$) consequently compared to the pre-test($M=3.36$, $SD=1.38$) and ($M=1.20$, $SD=1.41$). Except the total half answers, no significant differences were noted between the two tests.

Table 5.15. Descriptive and paired samples t-test outcomes for the experimental and control group and Comprehension Variables

Group	Variable	Pre	Post	Paired samples t-test	
		Mean/SD	Mean/SD	t-value	Significance (p)
Exp	Total right answers	3.36/1.38	4.12/1.48	-3.919	0.000
	Total wrong answers	1.20/1.41	0.64/1.35	3.218	0.003
	Total half answers	0.44/0.50	0.24/0.43	1.732	0.096
control	Total right answers	3.53/ 1.06	3.66/ 0.89	-0.694	0.498
	Total wrong answers	0.86/0.83	0.80/ 0.86	0.323	0.751
	Total half answers	0.60/0.63	0.53/0.51	0.456	0.719

For the control, no significant differences were noted between the two tests for comprehension variables.

However, the Paired t sample t-test explored the statistical differences, between the average pre-test scores and the average post-test scores within the same group. The experimental group showed a significant difference in their post-test for all of the variables while no differences were found in the control group. Therefore, it can be inferred that the difference between these two means (pre-test and post-test) for the experimental group compared to the control group is statistically significant to a 95.9% confidence level. This indicates that the developed mobile learning application has an important impact on improving the reading fluency and comprehension of students.

5.4.7 Independent sample t test

Independent samples t-test was used to check whether the mean scores of the two groups (Control vs Experimental) were significantly different from each other in each of the dependent variables at two periods.

Independent samples t-test for time 1 (pre-test) in Table 5.16 showed that there is a significant difference between the experimental and the control groups in total time (seconds) consumed

in reading the whole text ($t=2.18$, $p=0.035$). The experimental group took significantly longer time ($M=691.0$) compared to the control group ($M=413.40$). Moreover, there is a significant difference between the experimental and the control groups in reading Rate at 1 minute ($t=3.720$, $p=0.002$) and Rate at 3 minutes ($t=3.378$, $p=0.003$). The experimental group read significantly less words in 1 minute ($M=9.72$) compared to the control group ($M=26.53$) as well as in Rate in 3 minutes ($M=26.12$) for the experimental group and ($M=51.66$) for the control group. Also, there is a significant difference between the experimental and the control groups for WCPM at 1 minute ($t=3.510$, $p=0.003$) and WCPM in 3 minute ($t=3.195$, $p=0.004$). The experimental group read significantly less correct words in WCPM at 1 minute ($M=8.56$) compared to the control group ($M=23.33$) and WCPM in 3 minutes ($M=21.68$) compared to the control group ($M=44.00$).

Table 5.16 shows that the p-value for pre test for the total time in seconds, Rate at 1 minute, WCPM at 1 minute, Rate at 3 minutes and WCPM at 3 minutes variables are 0.035, 0.002, 0.003 0.003 and 0.004 respectively which are less than $\alpha = 0.05$ ($p < 0.05$). This means at pre-test level there was significant difference between the groups. On the other hand, the p-value for Accuracy at 1 minute, Accuracy at 3 minutes, comprehension variables (Total Right Answer, Total Wrong Answer and Total Half Answer), Total Right Words and Total Wrong Words are 0.316, 0.208, .679, .413, .384, .216 and .289 respectively which are greater than $\alpha = 0.05$ ($p > 0.05$) and hence there is no significant difference between the experimental and control group in these variables.

Table 5.16 Results of Independent Sample t-test for Differences between the Mean Pre-test Scores of the two Groups

Pre- test	Experimental	Control	Independent samples t-test	
	Mean/SD	Mean/SD	t-value	Significance (p)
Total time (sec.)	691.0/380.95	409.66/417.36	-2.182	.035
Rate in 1 min	9.72/7.24	26.53/ 16.57	3.720	.002
WCPM in1min	8.56/7.26	23.33/15.29	3.510	.003
Accuracy in 1min	80.61/25.47	86.6874/12.08	1.016	.316
Rate in 3 min	26.12/18.75	51.66/ 25.43	3.378	.003

WCPM in 3min	21.68/17.40	44.00/23.45	3.195	.004
Accuracy in 3min	77.56/16.87	83.87/11.40	1.280	.208
Total Right Answer- Comprehension	3.36/1.38	3.53. 1.06	.417	.679
Total Wrong Answer- Comprehension	1.20/1.41	.87/.83	-.828	.413
Total Half Answer- Comprehension	.44/.50	0.60/.632	.881	.384
Total Right Words (OutOf70words)	53.92/10.08	57.73/7.72	1.257	.216
Total Wrong Words (OutOf70words)	16.08/10.08	12.80/7.92	-1.074	.289

Furthermore, independent samples t-test was conducted to measure the difference between the experimental and the control groups at time 2 (post-test) as in Table 5.17. Significant difference was only found in two dependent variables, namely reading Rate at 1 minute ($t=2.084$, $p=0.049$), and Accuracy at 1 min ($t= -3.302$, $p=0.002$).

Table 5.17 shows that the p-value for post-test for the Rate at 1 minute and Accuracy at 1 minute variables are 0.049 and 0.002 respectively which are less than $\alpha = 0.05$. This means that there was a statistically significant difference between the two groups in the post-test scores only in those variables. In the reading rate at 1 min, the control group showed more reading words ($M=28.20$) compared to the experimental group ($M= 16.12$). Whereas the experimental group showed more accuracy at 1 minute ($M=91.42$) compared to the control group ($M=78.73$).

Table 5.17 Results of Independent Sample t-test for Differences between the Mean Post-test Scores of the two Groups

Post- test	Experimental	Control	Independent samples t-test	
	Mean/SD	Mean/SD	t-value	Significance (p)
Total time (sec.)	557.48/378.63	413.40/435.53	-1.101	.278
Rate in 1 min	16.12/13.74	28.20/19.76	2.084	.049
WCPM in 1min	15.20/13.61	24.20/19.41	1.578	.129
Accuracy in 1min	91.42/9.68	78.73/14.66	-3.302	.002
Rate in 3 min	34.80/22.07	49.67/25.47	1.946	.059
WCPM in 3min	31.20/22.10	41.33/24.61	1.345	.186
Accuracy in 3min	85.49/15.41	79.04/14.04	-1.322	.194
Total Right Answer-Comprehension	4.12/1.48	3.67/.90	-1.070	.291
Total Wrong Answer-Comprehension	.64/1.35	.80/.86	.410	.684
Total Half Answer-Comprehension	.24/.436	.53/.516	1.841	.077
Total Right Words (OutOf70words)	60.16/11.52	56.67/9.01	-1.003	.322
Total Wrong Words (OutOf70words)	11.84/11.52	15.3333/9.01	1.003	.322

To summaries, it should be noted that the control group had better scores before the experiment (pre-test), as seen in table 5.16, confirmed by more significant results showing better scores for the control group. However, it should also be noted that these differences were mostly eliminated at post-test level, and only 1 significant result was found favouring the control group. Therefore, it could be assumed that the use of the developed mobile application, has managed to reduce the gap between the experimental and control group. This was reflected in improvements in the experimental group between pre-test and post-test., with the control group showing stable/similar results and hence no improvement within this group.

5.5 Summary

This chapter has presented the full study results, which took place in the autumn term 2020 from September to the end of October in primary schools in Makkah, Saudi Arabia. The participants were second year primary school students, their parents and teachers. The methodology of this study has changed due to Covid-19 restrictions. The results were obtained from students pre/post-test, researcher observation, post experimental survey of the students, teachers interviews and parents survey, were discussed.

Chapter 6: Discussion Chapter

6.1 Introduction

The novel application discussed in this thesis was designed to improve learners' fluency and comprehension when reading in Arabic and increase their engagement while learning. Two separate experiments; the pilot study and the main study, were carried out, using the developed system, as described in chapters 4 and 5. The purpose of these two experiments was to observe whether the proposed mobile learning application operated effectively and whether it increased learners' fluency and comprehension as well as engaging them. A core component of each study was system testing and evaluation in terms of Usability and Engagement, with the main study additionally including a quantitative test-based approach to evaluation. This chapter will discuss the results of the main study covering children's technology background, the hypotheses (initial student ability, the children's fluency, comprehension and engagement after using the system and system usability and engagement) and teachers' interviews.

6.2 Technology Use at Home

All the children had internet access at their home, with the majority of children using a range of different devices and 60% of the students have their own device. Given the high percentage of children using devices, this would suggest participants had a high level of familiarity with mobile devices and touch screen interactivity, which supports the use of a tablet-based device, particularly as 80% of the children used mobile/tablet applications by themselves.

The high use of mobile devices for gaming (92.50%) compared to that for reading (17.50%), would suggest there is significant scope for bridging this gap with an engaging learning application. Moreover, parents corroborated this issue stating that their children liked and enjoyed playing games while they least enjoyed reading from these devices. The developed system aimed to provide children with material they can learn from through their favourite devices, that they could use independently and that would engage them in a similar way to gaming applications.

6.3 Discussion of the Hypotheses

The test scores for the experimental and control groups in the main study (see Chapter 5, section 5.4.5) were used to test the hypotheses regarding the effect of the mobile learning application on reading fluency and comprehension. Both an independent sample t-test and a paired samples

t-test were utilised to ascertain whether there were any statistically significant differences between the pre- and post-test scores in either group.

6.3.1 Hypothesis 1

The first hypothesis predicts that at pre-test, there should be no major difference in the reading fluency between the two groups, as it was expected that they would have the same level of fluency before using the proposed system. However, there was a statistically significant difference between the mean of the pre-test scores for the experimental group and those for the control group. This could be due to many reasons: firstly, the different sample size between the two groups (control= 15, experimental=25). Secondly, participation involved parental consent and it is possible that parents with children who were struggling might be more open to giving consent to enhance and improve their children's reading ability. As the developed system was targeting all children with varying reading abilities, this unexpected result further supports the idea that this system is particularly effective for those who need more support.

6.3.2 Hypothesis 2

The hypothesis declares that post-test the experimental group will do better than the control group, and that their post-test scores would be measurably higher than their pre-test scores. The mean post-test scores for the experimental group demonstrated a statistically significant difference. Evidently, the experimental group increased their reading fluency and comprehension more than the control group. Therefore, the second hypothesis was accepted and this means that the experimental group improved their fluency and comprehension after they had interacted with the learning materials via the proposed mobile learning system.

6.3.3 Hypothesis 3

The third hypothesis stated that there would be significant differences between pre-test and post-test scores in the experimental group, but show no significant difference in the control group. For group level, a repeated measures t-test was used to examine whether or not there was any significant variation between participants in the pre and post-tests for all variables. A significant difference was found in the experimental groups' scores in the post-test, which were significantly better than their scores in the pre-test for all variables except the total half answers variable (no significant differences were noted between the two tests). This indicates that the developed system has led to a significant improvement in reading time, Rate at 1 and 3 minutes, WCPM at 1 and 3 minutes, and helped the children to reduce their errors and increase their

ability to read correctly and accurately. On the other hand, there were no significant differences noted between the two tests for all variables for the control group.

Therefore, hypothesis 3 was accepted and this means that the experimental group improved their fluency and comprehension after learning the materials using the proposed mobile learning system.

6.3.4 Hypothesis 4

The fourth hypothesis stated that children would experience the developed system as easy to use and engaging and they would be satisfied with it.

The experiment was run with three sessions because it gave the researcher a very good indication of the children's progression with the system, from initial novice user to expert over the three sessions. Based on the researcher's observation, the application was consistently seen to be easy to use, without any difficulties. The children liked it, enjoyed using it and played with it in a very independent manner. They progressed very well with the help of the pictures and the read-aloud feature and in the last session, read observably faster and more accurately than in the previous sessions. They were also excited and engaged while playing and interacting with the application and did so without asking any questions. They improved over the three sessions and they seemed to become familiar with the system. The developed system appeared to help the children to learn and read while they played with it.

Based on the open-ended questions, 52% of the children reported that the whole system was easy to use, while some of them specifically mentioned some features they found helpful such as: pictures, words and sentences, creating stories and reading them and the sounds. This confirms that using this developed mobile learning application can assist children's learning without encountering any problems while using the system.

However, in the post experiment survey, 24% of children said they found the story sentences quite long, 8% mentioned that creating stories at the expert level was quite difficult and 4% mentioned that the application font was small. Even though this resulted was expected as the developed system targeted different students with different abilities and needs, this could be enhanced if the number of the session increased rather than three sessions.

The majority of children were both comfortable and satisfied with the proposed application, and it will help them to enhance their education. This confirms that the use of the developed system can increase student engagement and satisfaction and this support H4 which shows that

the students found the developed system engaging with good usability and they will be satisfied.

6.4 Interviews with Teachers

The teachers liked the application, and believed it to be age-appropriate because of its simplicity and that it took into considerations children's individual differences in learning styles by containing clear pictures, sounds and uncomplicated words. Its gradual approach and guidance for children to read progressively, which is seen as an essential feature for early years education, was commented on. The teachers appreciated that the application started with words, then multiple words, sentences and then progressed to creating stories at two different levels (with and without questions) and then reading the short stories in two different versions. They felt that sharing the stories that the children created and read by themselves via voice recording onto the website, viewing the shared stories and having the ability to write comments on each story and see each other's comments were all key functionalities. They also said that the navigation restrictions which prevented progress to sentence level before ending the words level was a nice feature.

The teachers generally felt that the application would support the curriculum in an interactive way and help children in their learning process because it contained words with specific linguistic and grammatical features. Using the application would make the learning process more enjoyable, thus encouraging pupils to use it in their free time. Moreover, creating the stories via the drag-and-drop feature was another positive aspect mentioned by the teachers who said it would help pupils who might normally disengage with the Arabic class. They felt that such children might be encouraged because they could initially create their own stories without writing any words and thus benefit from the application.

Teachers identified many benefits of using the application; for example, they felt that it helped children who were unable to read by using sounds which the child tries to mimic; this feature helped the teacher to strengthen skills in the non-fluent pupils. They also thought that the pictures and read-aloud features in the application helped children to become independent and provided support for those pupils that did not receive this support at home. Additionally, the read-aloud feature was seen as helping to correct pronunciation of the text, especially for children who did not like receiving corrections from their classmates. Creating stories and the flexibility to change pictures was felt to increase the vocabulary that the children were able to

read and understand; as every time they created a new story, they would have different words to read.

Teachers believe that the developed application would support cooperative learning in cases where the pupils were divided into groups of 5 and each pupil selected elements of the story. (For instance, the first pupil selects the background of the story, the second pupil selects the character, the third pupil selects the activity, the fourth pupil selects the emotion, and the last pupil reads the story). The application was also thought to support collaborative learning when groups created and shared their stories and were asked to critique each other's stories and compete among themselves. This would teach children how to work in teams.

Voice recording, sharing stories and viewing the shared stories from the website was felt to help children improve their performance and reading ability, because when they listened to themselves, they could self-correct their reading, and this would help them when reading aloud in order to get good comments. Commenting on each other on the website could enhance writing ability and children's self-confidence and motivation would be enhanced when they shared their stories and received feedback.

Teachers were asked about their pupils' attitudes when attending the Arabic language classes and whether the teachers would use the application to teach them. The teachers believed that their pupils would interact well with the developed application and they would like it more than just using the book, which could be monotonous. Using the application would change their attitudes as they would feel excited and motivated to engage.

However, the teachers had some criticisms as follows: Firstly, using the read-aloud features and sharing the stories necessitated an internet connection and this could be a problem as some schools do not have internet connection. Secondly, creating stories at the expert level could possibly be challenging for some pupils. This was noticeable for a few children during the observation sessions where almost half were unable to create stories at the expert level but this could be because of the short time available and the limited number of sessions. Moreover, they mentioned that voice recording could be difficult for shy and/ or non-fluent students when they sharing their story because they are not confident and their speech may be quiet when reading and this happened with some of the students during the practical sessions, but most of those students tried to create other stories where they tried their best to read correctly as well as loudly and started to feel confident.

At the end of the interviews, the teachers were asked to rate the system's functionality and its features in encouraging children to read and its ability to enhance children's reading skills through the use of storytelling, pictures, read-aloud features and sharing stories. All the teachers rated all the features as 10 out of 10. They also all agreed that they would download the developed application if it was available from the Apple store or Google Play store.

6.5 Summary

This chapter discussed the effect of implementing of the mobile learning application which combined UDL and digital storytelling on students fluency, comprehension, engagement and satisfaction when reading in Arabic. The hypotheses H1, H2 and H3 were statistically tested using the independent sample t-test and paired sample t-test. The results of these tests showed an increase in students reading fluency and comprehension. The hypotheses H2 and H3 were accepted, but H1 was rejected as there were measurable differences in the pre-test scores between the experimental group and the control group. In addition to that, researcher's observation, teachers interviews and the post-experiment survey results demonstrated that the system is highly engaging with good usability which supports H4. The overall findings support that a system based on mobile, UDL and digital storytelling can increase student fluency, comprehension engagement and satisfaction.

Chapter 7: Conclusions and Recommendations for Future Work

This chapter describes the overall conclusions of this research and discusses the significant benefits of the novel educational mobile application which has been assessed by two studies (the pilot and main studies). It also presents the answers to the research questions, the research contributions, study limitations and future directions.

7.1 Conclusion

The aim of this research was to show that the developed novel mobile application improved children's fluency, comprehension, engagement and satisfaction when reading in Arabic. In order to evaluate the system's effectiveness, two studies were performed with multiple experiments in different schools in Saudi Arabia. Both studies were successful and provided positive results. The pilot study demonstrated the effectiveness of the experimental methodology and the system's functionalities. The experiment ran successfully, the pupils were able to use the system and the results were obtained and gathered. The main study was carried out to answer the research questions and examine the research hypotheses. The results of the main study strongly indicated the effectiveness of the developed system and demonstrated how it contributed to increasing the students' fluency and comprehension, engagement and satisfaction levels.

7.2 Research Contributions

This research has nine contributions as follows:

1. Development of a novel system which integrates three existing e-learning methods (mobile learning, digital storytelling and UDL) for learning in Arabic language teaching.
2. This research provides a novel e-learning system that increases children's fluency and comprehension, engagement and satisfaction levels.
3. This study contributes to the literature on mobile learning in Arabic by providing an Arabic mobile learning application that is in-line with the formal curriculum of the Saudi primary school.
4. This study contributes to the literature on Universal design for learning (UDL) by providing an empirical study through practical application that applies the principle of UDL.
5. This study contributes to the literature on digital storytelling in the Arab context generally, and Saudi Arabiaspecifically by providing a digital storytelling mobile

application.

6. A methodology for studying developed e-learning applications with second year primary school children from different primary schools in Saudi Arabia. Moreover, an online methodology for studying developed e-learning applications with second year primary school children from different primary school in Saudi Arabia. (Modifications made due to the Covid-19 pandemic).
7. Insight in to the perceptions of different stakeholders in e-learning systems; students, parents/guardians and teachers, regarding their perception of e-learning and using the developed system in educating children in the class in a Saudi Arabian context.

7.3 Research Questions

The central question in this research was:

“Does the proposed novel educational mobile learning application enhance learners’ reading fluency, comprehension, engagement and satisfaction while reading in Arabic, and make learning more effective than traditional learning styles?”

To answer the research question, there were four key hypotheses, which were evaluated based on the findings obtained from students’ pre- and post-test scores (used for measuring fluency and comprehension), as well as observations and questionnaires (used for measuring engagement and satisfaction). Hypotheses were as follows:

H1: The pre-test will show no significant difference in reading fluency and comprehension between the experimental group and the control group.

H2: The post-test will show a measurable increase in reading fluency and comprehension of the experimental group.

H3: Comparison of pre-test and post-test scores will reflect measurable positive differences in experimental group, and show no significant difference in the control group.

H4: Students will find the developed system engaging with good usability and good level of satisfaction.

H1, H2 and H3 hypotheses were statistically tested. H2 and H3 were accepted, but H1 was rejected as there were measurable differences in the pre-test scores between the experimental group and the control group.

Based on the researcher's observation, the application was seen to be easy to use by the students. They liked it, enjoyed using it and played with it independently. They progressed very well with the help of the pictures and the read-aloud feature. They were also excited and engaged while playing and interacting with the application. They improved over the three sessions and they became familiar with the system. Moreover, the post-experiment survey, which was conducted with the children to test system usability and user satisfaction, demonstrated that the majority were satisfied with the system. This, in turn, supports H4 which predicted that the students would find the developed system engaging with good usability and be satisfied with it.

7.4 Research Limitations

This research has some limitations as follows:

There was a small sample size for the main study due to the limited accessibility of potential participants. This was due to school closures and the transition to online teaching due to the Covid-19 pandemic.

The control and experimental group were expected to be at the same level at the starting point of the pre-test. This did not happen for a number of reasons discussed in section 6.3.1, but would likely be addressed by a larger participant group in future studies.

The number of observation sessions could have been increased rather than 3 sessions to obtain a better overview about the children's interaction with the system.

The study was completed online due to the Covid-19 pandemic, this could have affected the results obtained; as this entailed the researcher observing children interacting with the proposed system only via video conferencing. This could have prevented the researcher from observing everything, which would have been more possible if the observation had been done face-to-face.

Even though the students were from both genders, only female early childhood teachers were interviewed as the researcher could only access female schools and schools that applied early childhood programmes where only female teachers exclusively educate the children in these schools.

The main study was restricted to public schools in Makkah, Saudi Arabia, and although this is thought to be representative it would be ideal to run this study in other Saudi cities.

7.5 Future Work

This section provides recommendations for future work as follows:

As the main study was completed during the pandemic and school closure, it would be advantageous to examine the level of engagement that the application provides in face-to-face classes at school when compared to the traditional way of learning (i.e., using pen, paper and physical text books). Further study needs to be conducted face-to-face and in the real school environment, as this would allow both a comparison with the findings of this study and would shed light on related topics such as collaborative work using the application and the use of the application in tandem with standard teaching.

The number of the practical session could be increased to obtain a deeper understanding about how children interact with the system, and how that interaction progresses over time.

The application needs further features to support accessibility, such as zooming in to allow the children to make the text/pictures larger. This would be especially relevant for children with any visual impairment.

Additionally, pictures need to be added when testing the students in the pre/post-tests to show what is being described, as although almost all read the first version of their stories (which were divided into separate pages with pictures) many just skipped the second version of the stories, which contained the full story in one page with no pictures.

The developed system could be expanded to cover the first three years of early childhood education and the experiment could be conducted in different schools in different cities in Saudi Arabia. Enlarging the experiment in this way would make the results more generalizable.

Finally, the experiment in this study was conducted with children without any diagnosed disabilities, therefore, it would be useful to conduct the study with groups of children with disabilities. It is expected that a modified version of this application would be very effective at supporting learners with disabilities as this is one of the key goals of UDL.

7.6 Summary

This thesis has reviewed the literature in order to find the knowledge gaps in the area and developed an educational mobile learning application to address this gap. The application uses digital storytelling and UDL as an interactive tool to increase fluency, comprehension, engagement and satisfaction. Two studies were conducted to test and evaluate the developed system and the results obtained were overwhelmingly positive.

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Appendices

Appendix 1: Approvals



المملكة العربية السعودية
وزارة التعليم
جامعة أم القرى



الموضوع: بشأن طلب تسهيل مهمة باحث

سعادة مدير التعليم بمنطقة مكة المكرمة سلمه الله

السلام عليكم ورحمة الله وبركاته وبعد:

نفيد سعادتكم بأن عضوة هيئة التدريس بالكلية لدينا المحاضرة: سارة بندر دهيان الحربي، والمتعنة حالياً إلى جامعة ساكس البريطانية لدراسة الدكتوراة في كلية الهندسة والمعلوماتية ترغب القيام بتطبيق الاداة الخاصة بدراستها والتي بعنوان (تطوير التعلم المجهول عن طريق دمج مبادئ التصميم العالي للتعلم و رواية القصص الرقمية) و تستهدف الدراسة طالبات ومعلمات الصفوف الاولى بالمرحلة الابتدائية.

امل من سعادتكم التكرم بتوجيه من يلزم لتسهيل مهمة الباحثة لتطبيق ادوات البحث وتمكينها من جمع المعلومات المطلوبة لغرض الدراسة.

هذا وتقبلوا خالص تحياتي وتقديري...

عميد كلية الحاسب الآلي بالليث



د. إسكندر محمد آدم هوساوي



الرقم :
التاريخ : ١٤٤١/٣/٢٠ هـ
المرفقات :

وزارة التعليم
الإدارة العامة للتعليم بمنطقة مكة المكرمة
إدارة التطوير والتطوير

وزارة التعليم
الإدارة العامة للتعليم بمنطقة مكة المكرمة
إدارة التطوير والتطوير

الموضوع : بشأن تسهيل مهمة باحثة

تمميم لجميع مدارس المرحلة الابتدائية الحكومية والأهلية (بنات)

المكرمة قائدة المدرسة /
السلام عليكم ورحمة الله وبركاته

بناءً على خطاب عميد الحاسب الآلي بالبيت رقم ٢١٦٩ وتاريخ ١٤٤١/٣/٧ هـ بشأن مطالبة المراسلات العليا/ سارة بنهر دهبيران الحري، والمتعلقة حالياً إلى جامعة ساسكس البريطانية لدراسة الدكتوراه والتي ترغب بتطبيق أدوات دراستها بعنوان:

"تطوير التعلم المحمول عن طريق دمج مبادئ التسميم العالمي للتعلم ورواية القصص الرقمية"

وبناءً على خطاب مديرة إدارة الإشراف التربوي رقم ١٦٤٧ وتاريخ ١٤٤١/٣/٢٠ هـ بشأن الموافقة على تطبيق أدوات الدراسة المرفقة في الرابط والباركود أدناه (مقابلة معلم قبل التجربة) وبعدها، استبانة أولياء الأمور، مقابلة الأطفال بعد التجربة، استبانة للأطفال قبل التجربة) على عينة من الأطفال ومعلمات الصفوف الأولية بالمرحلة الابتدائية.

عليه تأمل تسهيل مهمة الباحثة، شاكرين تعاونكم لخدمة البحث العلمي.

وتقبلوا تحياتنا...

مدير عام التعليم بمنطقة مكة المكرمة
د. أحمد بن محمد الزاوي

https://cutt.us/nd4WY

أم النجدي
صدر داخلي 17863
1441/03/21

Ethical Review Application (ER/SA817/1) Sara Alharbi

Amendments: ER/SA817/2

Project Title	Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.
Status	Conditional approval
Email	sa817@sussex.ac.uk
Phone No.	07411161811
Applicant Status	PG (Research)
Department	Informatics
Supervisor	Newbury, Paul F
Project Start Date	12-Nov-2019
Project End Date	29-Dec-2019
External Funding in place	No
External Collaborators	No
Funder/Project Title	
Name of Funder	Sara Bandar D Alharbi

Ethical Review Application (ER/SA817/4) Sara Alharbi

Parent Application:ER/SA817/3

Project Title	Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling. (COPY)
Status	Conditional approval
Email	sa817@sussex.ac.uk
Phone No.	07411161811
Applicant Status	PG (Research)
Department	Informatics
Supervisor	Newbury, Paul F
Project Start Date	21-Sep-2020
Project End Date	20-Dec-2020
External Funding in place	No
External Collaborators	No
Funder/Project Title	
Name of Funder	

Appendix 2: Ethical Review Requirements for the pilot study



2.1 Head teacher's consent sheet

Researchers are required to abide by ethical guidelines when working in schools. These cover topics such as gaining appropriate consent, permitting children to withdraw from the study, and keeping data confidential. We would be grateful if you could check and sign the following sheet to show that you approve of the research procedures for this study.

PROJECT NAME

Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

APPROVED BY

University of Sussex Sciences & Technology Cross-Schools Research Ethics Committee
(crecscitec@sussex.ac.uk)

NAME OF RESEARCHER VISITING THE SCHOOL

Sara Alharbi (sa817@sussex.ac.uk)

NAME OF PROJECT SUPERVISORS

Dr. Paul Newbury (P.Newbury@sussex.ac.uk) and Dr. Phil Watten (P.L.Watten@sussex.ac.uk).

PERIOD OF VISITS

Autumn Term 2019

CLASSES/YEAR GROUPS VISITED

Year 2

PROJECT DESCRIPTION

We wish to invite your students to take part in a research study to *interact with* the novel mobile learning app for learning Arabic in primary schools in Saudi Arabia, thus supporting effective and interactive learning within the classroom.

PROCEDURE

The research will take place in your school. We aim to test 40 children, their parents/ guardians and 2 Arabic language teachers. First, children will complete a short questionnaire before they begin the practical session which should last approximately 30 to 45 minutes. Then, children will be given a tablet which contained on the mobile application (the system). This mobile application will allow the student to create their own stories. The app will contain on pictures, words and read aloud feature. Furthermore, children will be observed while using the system and be interviewed after using the system. The session will be audio recorded using a recorder

to capture the researcher observation's notes. Moreover, the Arabic language teachers will be interviewed at the school before and after the experiment. The interview will be audio recorded using a recorder to capture teachers answers. Furthermore, a short questionnaire will be sent to the parents/ guardians.

CONSENT

Teachers will be sent an information letter with details of the study and a consent form to be signed in order to participate in the study. Parents/carers will be sent an information letter with details of the study and a permission form to be signed and returned in order for them and their child(ren) to participate in the study. Teachers and parents/carers should be given at least one week to read and respond to the letter. Children will be asked for verbal consent to participate in the study after receiving an initial briefing on the nature of the study and the procedures involved. Teachers, children and their Parents/carers will also be given the option to withdraw from the study at any point.



Please sign below to confirm that you:

- Understand the requirements of teachers who take part in the research
- Understand the requirements of children who take part in the research
- Have received detailed descriptions of the methods and materials to be used
- Give approval for the research to take place at your school.

Name of school: _____

Name of [Head Teacher]: _____

Signature: _____

Date: _____



2.2 Consent form for teachers

Title of Project: Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

Name of Researcher and School: Sara Bandar D Alharbi. School of Engineering and Informatics.

C-REC Ref no: <Insert ER no.>

Please tick box

- | | | |
|--|--------------------------|--------------------------|
| • <i>I consent to being interviewed by the researcher</i> | ☐ | ☐ |
| • <i>I agree to allowing the interview to be audio-recorded.</i> | ☐ | ☐ |
| • <i>I agree to making myself available for a further interview should it be required</i> | ☐ | ☐ |
| • <i>I understand that I will be given a transcript of data concerning me for my approval before being included in the write up of the research</i> | ☐ | ☐ |
| • <i>I consent to the use of anonymised quotes in publications from the research</i> | ☐ | ☐ |
| • <i>I understand that I will be given a transcript of any data that I have provided for my approval before being included in the write up of the research</i> | ☐ | ☐ |
| • <i>I understand that in exceptional circumstances e.g. where the health, welfare and safety of myself or others is compromised by information I might disclose, the researcher will be legally required to pass this information onto an appropriate individual or agency.</i> | ☐ | ☐ |
| • <i>I understand that any information I provide is confidential, and that no information that I disclose will lead to the</i> | ☐ | ☐ |

identification of any individual in the reports on the project, either by the researcher or by any other party

- I consent to the processing of my personal information and data for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the General Data Protection Regulation (GDPR) 2016. ☐ ☐
- I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way nor do I have to give reasons for this. ☐ ☐
- *I consent to my data being deposited in the UK Data Archive for re-use in future research and analysis. I understand that it will be fully anonymised before deposit.* ☐ ☐
- I agree to take part in the above University of Sussex research project ☐ ☐

Name:

Signature

Date:

2.3 Consent form for parents

Title of Project: Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

Name of Researcher and School: Sara Bandar D Alharbi. School of Engineering and Informatics

C-REC Ref no: <Insert ER no.>

	<i>Please tick box</i>	
	YES	NO
• <i>I consent to being part of the study.</i>	☐	☐
• <i>I agree to complete the questionnaire based on my knowledge.</i>	☐	☐
• <i>I understand that I will be given a transcript of data concerning me for my approval before being included in the write up of the research</i>	☐	☐
• <i>I understand that confidentiality cannot be guaranteed for information which I might disclose in the questionnaire.</i>	☐	☐
• I understand that any information I provide is confidential, and that no information that I disclose will lead to the identification of any individual in the reports on the project, either by the researcher or by any other party	☐	☐
• I have read the information sheet, had the opportunity to ask questions and I understand the principles, procedures and possible risks involved.	☐	☐
• I consent to the processing of my personal information and data for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the General Data Protection Regulation (GDPR) 2016.	☐	☐

- I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

☐☐

- I agree to take part in the above University of Sussex research project

☐☐

Name:

Signature

Date:



2.4 Consent form for parents for their children

Title of Project: Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

Name of Researcher and School: Sara Bandar D Alharbi. School of Engineering and Informatics.

C-REC Ref no: <Insert ER no.>

Please tick box

- | | | |
|---|--------------------------|--------------------------|
| • I consent my child being interviewed by the researcher | ☐ | ☐ |
| • I consent my child being observed by the researcher | ☐ | ☐ |
| • I consent my child being asked by the researcher | ☐ | ☐ |
| • I agree to allowing the interview to be audio-recorded. | ☐ | ☐ |
| • I agree to allowing the observation to be audio-recorded. | ☐ | ☐ |
| • I agree to making my child available for a further interview should it be required | ☐ | ☐ |
| • I agree to making my child available for a further observation should it be required | ☐ | ☐ |
| • I understand that the recordings will be stored anonymously, using password-protected software and will be used for specific research purposes. | ☐ | ☐ |
| • I understand that I will be given a transcript of data concerning me for my approval before my child being included in the write up of the research | ☐ | ☐ |
| • I consent to the use of anonymized quotes in publications from the research | ☐ | ☐ |
| • I understand that I will be given a transcript of any data that I have provided for my approval before being included in the write up of the research | ☐ | ☐ |
| • I understand that in exceptional circumstances e.g. where the health, welfare and safety of myself or others is compromised | ☐ | ☐ |

by information I might disclose, the researcher will be legally required to pass this information onto an appropriate individual or agency.

- I understand that any information my child provide is confidential, and that no information that my child disclose will lead to the identification of any individual in the reports on the project, either by the researcher or by any other party ☐ ☐
- I have read the information sheet, had the opportunity to ask questions and I understand the principles, procedures and possible risks involved. ☐ ☐
- I consent to the processing of my child personal information and data for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the General Data Protection Regulation (GDPR) 2016. ☐ ☐
- I understand that my child participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way nor do I have to give reasons for this. ☐ ☐
- *I consent to my child data being deposited in the UK Data Archive for re-use in future research and analysis. I understand that it will be fully anonymised before deposit.* ☐ ☐
- I agree for my child to take part in the above University of Sussex research project ☐ ☐

Name of Child

Name of Parent or Guardian

Age of child

Date

Signature



2.5 Parents information sheet

PROJECT NAME

Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

INVITATION TO TAKE PART

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

What is the purpose of the study?

The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia.

Why have I been invited to participate?

As a parent who is your child is a student who study the Arabic subject in primary schools in Saudi Arabia. it of great value to have you participating for the purpose of this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

If you decide to take part in this study you will complete the questionnaire. You may review the questionnaires before deciding whether take part.

What are the possible disadvantages and risks of taking part? (where appropriate)

The project has a system, which allows student to create short stories from existing material which will be provided by the app and then share these stories, and you will only be required to complete the questionnaire.

What are the possible benefits of taking part?

Taking part in this study will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

Will my information in this study be kept confidential?

The data you produce during this study will be kept confidential and your name will not be used nor associated with the data in papers, dissertation, thesis, reports, or any printed or non-printed volumes associated with this study.

What should I do if I want to take part?

If you wish to take part in this research please contact Sara Alharbi either telling her in person or emailing her at sa817@sussex.ac.uk

What will happen to the results of the research study?

The result of this research will be used in thesis for PhD degree and also for publication purposes. They can be accessed through the university archived theses and/or published sources. The data generated from this experiment can be re-used with other research publications in the same area.

Who is organising and funding the research?

I am conducting the research as a student at University of Sussex . The organizers of this research are Mrs Sara Alharbi, Dr Paul Newbury, Dr Phil Watten.

Contact for Further Information

For further information on this research you can contact: Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively.

The researcher:

Sara Alharbi

sa817@sussex.ac.uk

Chichester 1 room CI 128

INSURANCE

The University of Sussex has insurance in place to cover its legal liabilities in respect of this study.

THANK YOU FOR TAKING TIME IN READING THIS INFORMATION SHEET

Date

06/09/2019



2.6 Teachers information sheet

PROJECT NAME

Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

INVITATION TO TAKE PART

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

What is the purpose of the study?

The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia.

Why have I been invited to participate?

As a teacher who teach the Arabic subject in primary schools in Saudi Arabia, it of great value to have you participating for the purpose of this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

If you decide to take part in this study you will be interviewed which will be audio recorded.

What are the possible disadvantages and risks of taking part? (where appropriate)

The project has a system, which allows student to create short stories from existing material which will be provided by the app and then share these stories, and you will only be required to interviewed twice during the study, once before using the system and once after using the system.

What are the possible benefits of taking part?

Taking part in this study will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

Will my information in this study be kept confidential?

The data you produce during this study will be kept confidential and your name will not be used nor associated with the data in papers, dissertation, thesis, reports, or any printed or non-printed volumes associated with this study.

What should I do if I want to take part?

If you wish to take part in this research please contact Sara Alharbi either telling her in person or emailing her at sa817@sussex.ac.uk

What will happen to the results of the research study?

The result of this research will be used in thesis for PhD degree and also for publication purposes. They can be accessed through the university archived theses and/or published sources. The data generated from this experiment can be re-used with other research publications in the same area.

Who is organising and funding the research?

I am conducting the research as a student at University of Sussex . The organizers of this research are Mrs Sara Alharbi, Dr Paul Newbury, Dr Phil Watten.

Contact for Further Information

For further information on this research you can contact: Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively.

The researcher:

Sara Alharbi

sa817@sussex.ac.uk

Chichester 1 room CI 128

INSURANCE

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THANK YOU FOR TAKING TIME IN READING THIS INFORMATION SHEET

Date

06/09/2019



2.7 Parents for their children information sheet

PROJECT NAME

Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

INVITATION TO TAKE PART

Your child is invited to take part in a research study to interact with the novel mobile learning app for learning Arabic in primary schools in Saudi Arabia , thus supporting effective and interactive learning within the classroom. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

What is the purpose of the study?

The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia. This app will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

Why has my child been invited to participate?

As a student who study the Arabic subject in year 2 in primary schools in Saudi Arabia and we are expecting to test 40 children from year 2 of School. It of great value to have your child participating for the purpose of this research.

Does my child has to take part?

It is up to you to decide whether or not to allow your child to participate in this research study. If you do decide for your child to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide for your child to take part your child is still free to withdraw at any time and without giving a reason.

Choosing for your child to either take part or not take part in the study will have no impact on your child's marks, assessments or future studies.

What will happen to my child if they take part?

The session should last approximately 30 to 45 minutes and be take place at School during normal hours. If you decide for your child to take part in this study your child will complete a short questionnaire before the session phase. In the session, your child will be given a tablet which contained on the mobile application (the system). This mobile application will allow the student to create their own stories. The app will contain on pictures, words and read a loud feature. The session should last approximately 30 to 40 minutes and be take place at School during normal hours. Your child will be observed while using the system and be interviewed after using the system. The session will be audio recorded using a recorder to capture my observation's notes. You may review the mobile app content, questionnaires and interview questions before deciding whether take part.

What are the possible disadvantages and risks of taking part?

During the session, your child will interact with the tablet which will pose no additional risk to your child's safety.

What are the possible benefits of taking part?

Taking part in this study will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

Will my child information in this study be kept confidential?

The data your child produce during this study will be kept confidential and your child name will not be used nor associated with the data in papers, dissertation, thesis, reports, or any printed or non-printed volumes associated with this study.

What will happen to the results of the research study?

The result of this research will be used in thesis for PhD degree and also for publication purposes. They can be accessed through the university archived theses and/or published sources. The data generated from this experiment can be re-used with other research publications in the same area.

Who is organising and funding the research?

I am conducting the research as a student at University of Sussex . The organizers of this research are Mrs Sara Alharbi, Dr Paul Newbury, Dr Phil Watten.

Contact for Further Information

For further information on this research you can contact: Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively.

The researcher:

Sara Alharbi

sa817@sussex.ac.uk

Chichester 1 room CI 128

INSURANCE

The University of Sussex has insurance in place to cover its legal liabilities in respect of this study.

THANK YOU FOR TAKING TIME IN READING THIS INFORMATION SHEET

Date

06/09/2019

2.8 Recruitment letter for parents

I am a PhD student in the School of Engineering and Informatics at the University of Sussex, and I am conducting research on a mobile learning system aimed at helping children learning to read. The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia. This system allows student to create short stories from existing material which will be provided by the app and then share these stories. This app will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

This study will be completed as part of the Arabic language subject of second year primary schools in Saudi Arabia, and you are receiving this letter as your child is a student who is taking this module. I am looking for participants and would be very grateful if you and your child would be willing to take part in my study. If you agree to do so, you will have the chance to find out more about the study before coming to any decision. You and your child would be under no obligation to take part and this will have no impact on your child's marks, assessments or future studies. It is completely up to you whether to allow your child to participate in this research study.

The project is a term-long experiment and your child participation will be needed during the whole term, however you will be given a short questionnaire to complete and your child will have the chance to be familiar with new educational tool with the help of me or your child's teacher. The data produced from your and your child's participation will be kept confidential and your names will not be used nor associated with the data in papers, dissertations, or any printed or non-printed volumes associated with this study. The result of this study will be used in my thesis for a PhD degree and also for publication purposes and can be accessed through the university archived theses library and/or published sources.

My research is supervised by Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively. The study will be approved by the Sciences and Technology Cross-Schools Research Ethics Committee (CREC:crecscitec@sussex.ac.uk).

Thank you and Best Regards,
Mrs. Sara Bandar Alharbi
School of Engineering and Informatics
Department of Informatics
University of Sussex
Sa817@sussex.ac.uk

2.9 Recruitment letter for teachers

I am a PhD student in the School of Engineering and Informatics at the University of Sussex, and I am conducting research on a mobile learning system aimed at helping children learning to read. The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia. This system allows student to create short stories from existing material which will be provided by the app and then share these stories. This app will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

This study will be completed as part of the Arabic language subject of second year primary schools in Saudi Arabia, and you are receiving this letter as a teacher who is teaching this module. I am looking for participants and would be very grateful if you would be willing to take part in my study. If you agree to do so, you will have the chance to find out more about the study before coming to any decision. You would be under no obligation to take part. It is completely up to you whether to participate in this research study.

The project is a term-long experiment and your participation will be needed during the whole term, however you will have the chance to be familiar with new educational. The data produced from your participation will be kept confidential and her name will not be used nor associated with the data in papers, dissertations, or any printed or non-printed volumes associated with this study. The result of this study will be used in my thesis for a PhD degree and also for publication purposes and can be accessed through the university archived theses library and/or published sources.

My research is supervised by Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively. The use of email to recruit participants for this study will be approved by the Sciences and Technology Cross-Schools Research Ethics Committee (CREC:crecscitec@sussex.ac.uk).

Thank you and Best Regards,

Mrs. Sara Bandar Alharbi
School of Engineering and Informatics
Department of Informatics
University of Sussex
Sa817@sussex.ac.uk



2.10 Checklist: Verbal consent form for participants

Title of Project: Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

Name of Researcher and School: Sara Bandar D Alharbi. School of Engineering and Informatics

C-REC Ref no: <Insert ER no.>

A. Process of obtaining verbal consent from research participants:

1. Give an account of how you will verbally **explain** to the research participants as clearly as possible and in terms that they are familiar with:
 - The **aims** and **objectives** of your research;
 - The reasons why you have **selected** them for this research;
 - The reasons why their story/knowledge/understanding/opinions are **relevant** to your research;
 - The ways in which the research data will be **used**: for example, in a dissertation/thesis/publications/blogs/reports/policy documents.

I am conducting research on a mobile learning system aimed at helping children learning to read. The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia. This system allows student to create short stories from existing material which will be provided by the app and then share these stories. This app will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

This study will be completed as part of the Arabic language subject of second year primary schools in Saudi Arabia. The participants of this study will be the teachers who teach Arabic language in Schools in Saudi Arabia, students who are taking this module and their parents.

The data produced from the participants will be kept confidential and their name will not be used nor associated with the data in papers, dissertations, or any printed or non-printed volumes associated with this study. The result of this study will be used in my thesis for a PhD degree and may be used in publications, reports or presentations derived from the research project which can be accessed through the university archived theses library and/or published sources.

2. I will **verbally explain** to the research participants:

- That they can **withdraw** from the research at any time without giving a reason, and without being penalised or disadvantaged in any way and/or that they can tell me not to use certain types of information at any time;
- What **confidentiality** means in the context of the research and how confidentiality will be maintained in this particular context (OR explain why confidentiality cannot be maintained in this particular case – e.g. focus group);
- What **anonymity** means and how it will be maintained in this particular context (OR I will ask approval for the use of their name/location/company/organisation in the final report/dissertation/further publication).

3. Describe below how you will **verbally explain** to your informants that they can **withdraw** from the research at any time, what **confidentiality** and **anonymity** mean in your research context, and how you will explain these terms to your informants:

Your participation is voluntary, that you can choose not to participate in part or all of the project, and that you can withdraw at any stage of the project without being penalised or disadvantaged in any way.

Your answers will be completely anonymous. Any personal information collected, that could identify you, will remain strictly confidential. Therefore, any information you provide is confidential, and that no information that you disclose will lead to the identification of any individual in the reports on the project, either by the researcher or by any other party.

Your information will be treated as strictly confidential and handled in accordance with the Data Protection Act 1998.

After the data are collected, the files will be downloaded and transferred from the collection device e.g. audio recorder and will be saved on a secure drive that is only accessible to the researcher and the data will be deleted from collection devices as soon as all of the data have been successfully transferred to the secure drive. The files should will be saved in such a way that none of the research participants can be identified, by ensure that first names and last names will be removed and saved separately.

4. I will verbally **check** with the research participants that (tick, as applicable):

- They are happy to be interviewed and/or observed by me;
- They are happy for me to be present at and/or participate in their activities;
- They are happy for me to take notes on the interview/observations/interactions;
- They are happy for the interview/observation/interaction to be:
 - photographed
 - video taped
- audio taped

• ***Where photographs, video or audio tape are to be shown to others, specific and separate consent should be sought in written, video or audio form.***

- ***This consent should involve a full explanation of the kinds of contexts in which these media are to be shown.***
- ***Media should not be published – online or elsewhere – without specific consent.***
- They are happy to be contacted again for a further interview should that be required.

5. I will give the research participants the opportunity to **ask any questions** about any of the above or any other concerns they may have.

6. I understand that seeking verbal consent will involve explaining all I have documented above and that verbal consent is an ongoing process. I understand that I will need to document the ongoing process of verbal consent.

B. Process in which verbal consent cannot be obtained:

If participant observation and/or other ethnographic research methods will be used in which verbal consent will not or cannot be sought/obtained, the following need to be considered by the researcher:

1)	Explain why the aims and objectives of the research cannot always be fully explained to the research participants (this might differ per group/individual):
2)	Explain why confidentiality and/or anonymity cannot be explained and/or maintained:
3)	Explain why research participants cannot be asked for approval for recording and/or particular use of information:
4)	Explain how you ensure that negative or harmful impacts of the research on the research participants will be minimised:

C. Researcher Training and Consultation of Professional Guidelines

1. I confirm that in the course of my research design, I have received the following training in the ethical aspects of my research (please give details of any modules, CPD or other research ethics training you have attended in the last 18 months):

2. I confirm that I have read and carefully considered the ethical guidelines of the main

professional associations for my subject area (eg: the ASA ethical guidelines: <https://www.theasa.org/ethics/guidelines.shtml>) and incorporated them into my research design.

Researcher Signature: ساره
Date: 06/09/2019

Appendix 3: Pilot study instruments

3.1 Pre experiment Children questionnaire

Student

Name:.....

Group:.....

.....

1. Do you use digital technology at home?



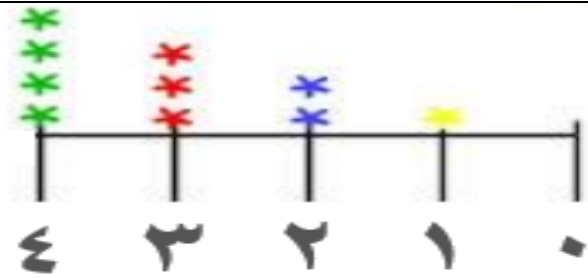
2. What type do you have?



3. What do you do?



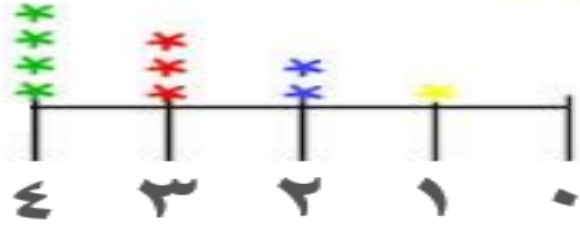
4. How often do you use per day?



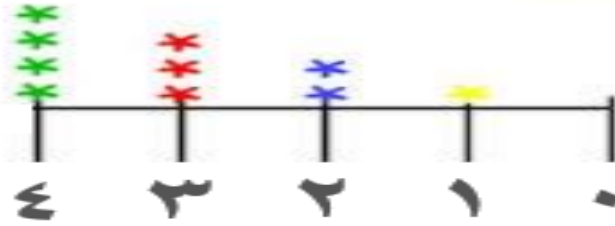
5. Does anyone at home reads to you Arabic books?



6. How many times a week?



7. How many Arabic books do you have at home?



8. 7. Do you enjoy listening to Arabic stories read to you?



3.2 Post-Experiment Children Interview Questions

General questions

1. Which is your favourite subject? Why? Prompts: ☐ Arabic. ☐ Math. ☐ Islamic study.
2. What about the Arabic period, how do you find it? Prompts: ☐ Enjoyable. ☐ Boring.
3. Do you think Language is useful? If so why/ why not?
4. Do you think learning language through iPad and applications will be useful? If so why/ why not?

Use of Story

1. What do you think of story/stories time do you like them? If so why/ why not?
2. When the teacher tells you story, how do you feel? Prompts: ☐ Excited. ☐ Happy.
3. Can you make a story by yourself? If you create a story will you be happy to share it with others?
4. Would you be happy to tell story in front of others?

Using the system

1. Numbering one thing you liked of the system?
2. Numbering one thing you did not like of the system?
3. Which parts of the system were easy to use?
4. Which parts of the system were difficult to use?
5. Did the system make the learning process more fun? Explain
6. Did the system provide help in the learning process? Explain
7. Did the pictures provide help in improving understanding of the words/texts? Explain
8. Did you find the read aloud features helped you to understand the words/ text? Explain
9. Did you find the creation of the stories helped you to have a better understanding of Arabic words and improved your knowledge? Explain
10. Did the sharing of your story make the learning process more fun? Explain
11. How do you feel about this system in enhancing reading in Arabic? 😊 😞
12. How do you feel about the use of storytelling in the system in enhancing reading in Arabic? 😊 😞
13. How do you feel about the use of pictures in the system in enhancing understanding Arabic words? 😊 😞
14. How do you feel about the use of read aloud in the system in enhancing reading ability in Arabic? 😊 😞

Closing question

Is there anything you want to tell me about it that we have not touched upon?

3.3 Parent Questionnaire

Your name: _____	Child name: _____
Relationship to the child: _____	Child School/Class: _____

To help provide background information about your child's early literacy and technology experiences, please take a few minutes to fill out the survey. Thank you for your cooperation.

A. Child information:

1. What is the gender of your child?
 - ☐ Male
 - ☐ Female

2. How old is your child?
 - ☐ 5 years
 - ☐ 6 years
 - ☐ 7 years

3. Does your child has Learning disability?
 - ☐ Yes
 - ☐ No
 - ☐ Prefer not to say

4. What does your child Reading ability?
 - ☐ Fluent
 - ☐ Learning
 - ☐ None
 - ☐ Prefer not to say

B. Home literacy environment

	True	False
1. My child has more than one picture book.	☐	☐
2. My child has at least 10 picture books	☐	☐
3. My child has at least 20 picture books.	☐	☐
4. My child has the following number of books: ☐ 0 ☐ less than 10 ☐ more than 10 ☐ more than 20		
5. My child plays reading and alphabet games on a computer.	☐	☐
6. My child plays reading and alphabet games on a tablet	☐	☐

7. My child plays reading and alphabet games on a mobile device.	☐	☐
--	--------------------------	--------------------------

C. Technology use

1. What kind of digital technology do you have at home? Please choose all you have:

- ☐ Internet
- ☐ Computer
- ☐ Laptop
- ☐ Tablets (iPad)
- ☐ Smartphones
- ☐ TV
- ☐ Video games (PlayStation)
- ☐ Other (please specify)

2. What kind of technology does your child enjoy? Please list all types:

- ☐ Internet
- ☐ Computer
- ☐ Laptop
- ☐ Tablets (iPad)
- ☐ Smartphones
- ☐ TV
- ☐ Video games (PlayStation)
- ☐ Other (please specify)

3. How much time does your child spend each day on each of the following techniques, if any?

Devices	Less than half an hour	Between half an hour to 1 hour	Between 1 hour to 2 hours	More than 3 hours
Laptop/Computer				
Tablets (iPad)				
Smartphones				
TV				
Video games (PlayStation)				
Tablet applications				
Other (please specify)				

4. How well is your child able to operate the following devices:

Devices	Does not know	Limited	Adequate	Very well
Laptop/Computer				
Tablets (iPad)				
Smartphones				
TV				
Video games (PlayStation)				
Tablet applications				

5. How old was your child when he used the following devices?

Devices	Child age
Laptop/Computer	
Tablets (iPad)	
Smartphones	
TV	
Video games (PlayStation)	
Tablet applications	

6. Does your child own mobile device or tablet (iPad)? Please indicate its type:

☐ Yes

☐ No

Type:

7. How long has your child used mobile devices and tablets (iPad):

☐ Never used a mobile device

☐ About 1-6 months

☐ About 6-12 months

☐ About 12-18 months

☐ About 18-24 months

☐ Longer than 24 months

8. How many days did your child use a mobile device or tablet (iPad) in the past five days:

☐ Never used a mobile device

☐ One day

☐ Two days

☐ Three days

☐ Four days

☐ Five days

9. How much time do you spend reading with your child every day?

- ☐ Less than 30 minutes
☐ 30 minutes to an hour
☐ Over an hour

10. How old was your child when you started reading to him/her?

- ☐ Less than a year
☐ Less than 2 years
☐ Less than 3 years old
☐ Under 4 years
☐ Less than 5 years old
☐ Less than 6 years old
☐ Less than 7 years old

11. Do you prefer reading stories to your child from a book or animated stories on the iPad? why?

- ☐ Book
☐ Tablet (iPad)

The reason:

12. Does your child prefer reading stories from a book or animated stories on the iPad? why?

- ☐ Book
☐ Tablet (iPad)

The reason:

13. What does your child prefer to use by himself? why?

- ☐ Book
☐ Tablet (iPad)

The reason:

15. What do you think about the following:

Statements	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Increasing the use of technology in the classroom to teach reading					
Using tablets (iPad) to teach reading					
Using tablets (iPad) in the classroom to teach reading					
Using iPad applications to teach reading					
Using iPad applications in the classroom to teach reading					

إستبيان لأولياء الامور

إسمك: _____	إسم الطفل: _____
صلتك بالطفل _____	المدرسة والصف: _____

هذه الاستبانة تهدف الى تزويدنا بالمعلومات الاساسية حول تجارب طفلك في تعلم القراءة والكتابة و استخدام التقنية. نأمل منكم تعبئة هذه الاستبانة والتي تستغرق بضع دقائق , وإعادتها للمدرسة. شكرا لتعاونكم.

1. معلومات الطفل:

1. ما هو جنس طفلك:

- ☐ ذكر
☐ أنثى

2. كم عمر طفلك؟

- ☐ 5 سنوات
☐ 6 سنوات
☐ 7 سنوات

3. هل يعاني طفلك من صعوبة في التعلم؟

- ☐ نعم
☐ لا
☐ أفضل عدم القول

4. ماهي قدرة طفلك على القراءة:

- ☐ يقرأ بطلاقة
☐ يتهجئ الحروف
☐ غير قادر على القراءة
☐ أفضل عدم القول

2. البيئة التعليمية في المنزل

خطأ	صح	
☐	☐	1. طفلي لديه كتاب مصور واحد على الأقل .
☐	☐	2. طفلي لديه ما لا يقل عن 10 كتب مصورة
☐	☐	3. طفلي لديه ما لا يقل عن 20 كتب مصورة
☐	☐	4. طفلي لديه عدد الكتب التالية: (الرجاء تحديد العدد)
	☐	0
	☐	أقل من 10
	☐	أقل من 20
☐	☐	5. يلعب طفلي ألعاب القراءة والحروف الأبجدية على جهاز كمبيوتر
☐	☐	6. يلعب طفلي ألعاب القراءة والحروف الأبجدية على جهاز ذكي لוחي (الايپاد)
☐	☐	7. يلعب طفلي ألعاب القراءة والحروف الأبجدية على الهاتف المحمول

3. استخدام التكنولوجيا

1. ما نوع التكنولوجيا الرقمية التي تملكها في المنزل؟ فضلا اختر جميع ما لديك:

- ☐ انترنت
☐ كمبيوتر
☐ كمبيوتر محمول
☐ أجهزة لوحية مثل الايباد
☐ هواتف ذكية
☐ تلفزيون
☐ ألعاب الفيديو مثل البلاي ستيشن
☐ أخرى (فضلا اذكرها).....

2. ما نوع التكنولوجيا التي يستمتع بها طفلك؟ يرجى ذكر جميع الأنواع:

- ☐ انترنت
☐ كمبيوتر
☐ كمبيوتر محمول
☐ أجهزة لوحية (الايباد)
☐ هواتف ذكية
☐ تلفزيون
☐ ألعاب الفيديو (البلاي ستيشن)
☐ أخرى (فضلا اذكرها).....

3. كم من الوقت يقضيه طفلك كل يوم على كل من التقنيات التالية ، إن وجدت؟

الأجهزة	أقل من نصف ساعه	من نصف ساعة الى ساعة	من ساعة الى ساعتين	أكثر من 3 ساعات
التلفاز				
الحاسوب				
الأجهزة اللوحية (الايباد)				
الهواتف الذكية				
ألعاب الفيديو مثل البلاي ستيشن				
تطبيقات الايباد				
أخرى (فضلا أذكرها)				

4. ما مدى قدرة طفلك على تشغيل الأجهزة التالية:

الأجهزة	ممتاز	معقول	محدود	لا أعرف
التلفاز				
الحاسوب				
الأجهزة اللوحية مثل الايباد				
تطبيقات الايباد				
ألعاب الفيديو مثل البلاي ستيشن				
الهواتف الذكية				
أخرى (فضلا أذكرها)				

5. كم كان عمر طفلك عندما استخدم الأجهزة التالية:

الأجهزة	عمر الطفل
التلفاز	
الحاسوب	
الأجهزة اللوحية مثل الايباد	
تطبيقات الايباد	
ألعاب الفيديو مثل البلاي ستيشن	
الهواتف الذكية	

6. هل يملك طفلك جهاز محمول أو لوحي (الايباد) خاص به؟ فضلا اذكر نوعه:

☐ نعم
☐ لا

نوعه:

7. كم المدة منذ أن استخدم فيها طفلك الأجهزة المحمولة واللوحية (الايباد):

☐ لم يستخدم جهاز محمول
☐ حوالي 1-6 أشهر
☐ حوالي 6-12 شهرا
☐ حوالي 12-18 شهرا
☐ حوالي 18-24 شهرا
☐ أطول من 24 شهرا

8. كم عدد الأيام التي استخدم فيها طفلك جهاز محمول أو لوحي (الايپاد) في الأيام الخمسة الماضية:

☐ لم يستخدم جهاز محمول على الإطلاق

- ☐ يوم
☐ يومان
☐ ثلاثة ايام
☐ أربعة أيام
☐ خمسة أيام

9. كم من الوقت تقضيه في القراءة مع طفلك كل يوم؟
☐ أقل من 30 دقيقة
☐ 30 دقيقة إلى ساعة
☐ أكثر من ساعة

10. كم كان عمر طفلك عندما بدأت القراءة له / لها؟
☐ أقل من سنة
☐ أقل من سنتين
☐ أقل من 3 سنوات
☐ أقل من 4 سنوات
☐ أقل من 5 سنوات
☐ أقل من 6 سنوات
☐ أقل من 7 سنوات

11. هل تفضل قراءة القصص لطفلك من كتاب أو قصص متحركة على الأجهزة اللوحية (الايپاد)؟ لماذا؟
☐ كتاب
☐ جهاز اللوحي(الأيپاد)
السبب:

12. هل يفضل طفلك قراءة القصص من كتاب أو قصص متحركة على الأجهزة اللوحية(الايپاد)؟ لماذا؟
☐ كتاب
☐ جهاز اللوحي(الأيپاد)
السبب:

13. ماذا يفضل طفلك أن يستخدم بنفسه؟ لماذا؟
☐ كتاب

☐ جهاز اللوحي(الأيپاد)

السبب:

14. ماهو رأيك بخصوص كلا ممايلي:

الأجهزة	أؤيد بشدة	أؤيد	محايد	أعارض	أعارض بشدة
• زيادة استخدام التقنية في الفصل الدراسي لتعليم القراءة					
• استخدام الاجهزة اللوحية (الايپاد) لتعليم القراءة					
• استخدام الاجهزة اللوحية (الايپاد) في الفصل الدراسي لتعليم القراءة					
• استخدام تطبيقات الايپاد لتعليم القراءة					
• استخدام تطبيقات الايپاد في الفصل الدراسي لتعليم القراءة					

3.4 Interviews with teachers

A. مقابلة المعلم قبل التجربة

Interviews with teachers before conducting the experiments

الاستخدام العام للتكنولوجيا

General use of technology

1. أخبريني عن طلابك (عمر الطلاب الذين تدرسينهم وعددهم وجنسهم).
Tell us who your students are? (Average number of students, their age group and their gender)?
2. هل تستخدمين التكنولوجيا في الفصل الدراسي الخاص بك؟ ماذا تستخدمين؟ متى تستخدمينه؟ (في اليوم / الأسبوع)
Do you use technology in your classroom? If so, what technology forms or tools do you employ and how often do you use them (on a weekly / daily basis)
3. هل تعتقدين أن التكنولوجيا ستحسن أدائك التدريسي؟ إذا كان الأمر كذلك ، فكيف؟
Do you believe that Technology can improve your ways of teaching? If so, explain how?
4. هل ترغبين باستخدام المزيد من التكنولوجيا في فصلك الدراسي ؟ إذا كان الأمر كذلك فكيف تريدين استخدامها؟
Would you prefer using more technology? if so, how would you like to integrate it?
5. هل تستخدم طلابك التكنولوجيا داخل الفصل الدراسي؟ ماذا يستخدمون؟ كيف يستخدمونها؟ متى يستخدمونها؟ (باليوم / الأسبوع) ما هو دورك خلال هذا الوقت؟
Do your students use technology inside the classroom? What technology tools do they use? When do they use them (on a weekly/ daily basis)? What role do you play while they are using them?
6. هل تعتقدين أن التكنولوجيا ستحفز الطلاب على تعلم القراءة بشكل أفضل؟ إذا كان الأمر كذلك ، فكيف؟
Do you believe that using technology in the classroom can motivate your students to gain reading skills better? If so, how?
7. هل هناك ما يعيق استخدامك التكنولوجيا في الفصل الدراسي؟ إذا كان كذلك، فما هي العوائق ؟
Are there any inhibitors that discourage you from integrating technology in your classroom? If so, what are these inhibitors?

8. ما هي العوامل المشجعة لاستخدامك التكنولوجيا في الفصل الدراسي؟

What factors can encourage you to use technology in your classroom?

9. هل هناك أي شيء آخر تودين أن تخبريني به عن استخدام التكنولوجيا في فصلك الدراسي؟

Is there anything else I should know about using technology in your classroom?

تعليم اللغة العربية

Arabic Language Teaching

1. ما رأيك في منهج اللغة العربية بشكل عام؟ كيف وجدته؟

What do you think, in general, of the Arabic language curriculum?

2. هل يمكنك أن تخبريني بشكل عام عن موقف الطلاب عندما يحضرون الى فصل اللغة العربية؟

Could you please tell me how your students feel when they attend Arabic language class?

3. ما هي استراتيجيتك في تعليم القراءة؟ لماذا اخترت هذه الاستراتيجيات؟ موجهات: * تفاعلي. * الإملاء.

What strategy do you implement in teaching reading skills? Why did you chose such strategy? Indications: (Interactive, dictation)

4. خلال شرحك للدرس، هل يمكن أن تخبرني بالخطوات الدقيقة التي تتبعينها لتقديم كلمات عربية جديدة للطلاب؟

What are the steps you follow when introducing new Arabic vocabularies to your students?

5. هل يمكن أن تخبريني كيف يتجاوب الطلاب للاستراتيجيات التي تستخدمينها لتعليم اللغة العربية؟ موجهات: * التمتع * التعلم

How do you students interact with the strategies you implement in teaching Arabic language? Indications: (enjoyment, learning).

6. إذا وجد الطالب صعوبة في قراءة أو فهم كلمة جديدة، كيف تساعدونه في فهمها واستيعابها؟ موجهات: * مزيد من الشرح * إعطاء بعض الأمثلة.

How do you help your students learn or read a new vocabulary if the face any difficulty? Indications: (giving a further explanation /giving examples).

7. هل تعتقد أن منهج اللغة العربية الحالي يلبي احتياجات الطلاب؟ موجهات: * مناسب لأعمارهم. * يساعد الأطفال * لا يساعد

In your opinion, does the Arabic language curriculum meet your students' need?

Indications: (Suitable for their age group /help them/doesn't help them)

استخدام القصة

Using Storytelling Technique

1. كمعلمة ، هل تستخدم أسلوب سرد القصص في الفصل الدراسي ؟ متى تستخدمينه؟ كيف تستخدمينه؟

As a teacher, do you use the storytelling technique? if so, When and how do you implement it?

2. ما رأيك في استخدام سرد القصص كطريقة لتعليم القراءة؟

What do you think of implementing storytelling technique in teaching Reading skills?

3. هل تعتقد أنه من المهم قراءة القصص في المدرسة؟ إذا كان الأمر كذلك لماذا؟

In your opinion, is reading stories in schools important? If so, why do you think so?

4. هل يمكن أن تخبريني عن مواقف الأطفال عندما تحكي لهم قصة؟ الموجهات: * الاستمتاع * التفاعل

How do your students respond to storytelling? Indications: (Do they enjoy /interact with that?)

السؤال الختامي

- هل تودين التحدث عن أي شيء لم نقم بتغطيته في المقابلة؟

Is there anything else you would like to add?

A. مقابلة المعلم بعد التجربة

Interviews with teachers after conducting the experiment

موقف المعلم و استخدام التطبيق

Teachers' attitudes and the use of the application

1. ما رأيك في التطبيق بشكل عام؟

In general, what do you think of the application?

2. هل تعتقد أن استخدام التطبيق سيساعدك على تحسين أدائك؟ إذا كان الأمر كذلك ، فكيف؟ إذا كانت الإجابة لا ، فلماذا؟

Do you think that using the application can help improving your performance? If so, explain how? If no, why do you think so?

موقف الطلاب

Students' attitudes

1. بعد استخدام النظام ، هل يمكن أن تخبرني بشكل عام عن موقف الطلاب من اللغة العربية؟

After using the application, what are your students' attitudes towards Arabic language learning?

2. وماذا عن موقفهم عند حضور دروس اللغة العربية؟ موجبات: * سعيد * مثير * ممل

How do your students will feel about attending Arabic language classes?

Indications: (happy, excited, bored)

3. هل تعتقد أن استخدام القصص كما هو مطبق في النظام (التطبيق) كوسيلة لعرض وتعليم اللغة العربية يلبي احتياجات الأطفال في هذه المرحلة؟ موجبات: * مناسب لأعمارهم * غير مناسب.

Do you believe that using storytelling, as applied in the application as a way of introducing and teaching Arabic Language. Meet students' needs at this stage?

Indications: (Suitable for their age group or not)

استخدام النظام

Using the application

1. كيف تقيمين فعالية التطبيق في تحسين قراءة الطلاب للغة العربية بطلاقة (من 1 إلى 10)؟

On a scale from 1-10, 1 being the lowest and 10 being the highest, how do you rate the effectiveness in improving your students' reading skills?

2. كيف تقيمين فعالية هذا التطبيق في تعزيز فهم القراءة لدى الطلاب باللغة العربية (من 1 إلى 10)؟

On a scale from 1-10, 1 being the lowest and 10 being the highest, how do you rate the effectiveness of this application in improving your students' reading comprehension skills?

3. كيف تقيمين فعالية هذا التطبيق في تعزيز مشاركة الطلاب في اللغة العربية (من 1 إلى 10)؟

On a scale form 1-10, 1 being the lowest and 10 being the highest, how do you rate the effectiveness of this application in enhancing students' participation in Arabic language classes?

4. كيف تقيمين فعالية استخدام الصور في تعزيز فهم الطلاب للكلمات العربية (من 1 إلى 10)؟

On a scale from 1 to 10, 1 being the lowest and 10 being the highest, how do you rate the effectiveness of using pictures in enhancing students' understanding of Arabic vocabularies?

5. كيف تقيمين استخدام القراءة بصوت عالٍ في تعزيز قدرة الطلاب على القراءة باللغة العربية (من 1 إلى 10)؟

On a scale from 1 to 10 , 1 being the lowest and 10 being the highest, how do you rate the effectiveness of using reading aloud technique in enhancing students' reading skills.

6. ما هي أكثر الجوانب إيجابية في التطبيق ؟

What are the most positive aspects of the application?

7. ما هي أكثر الجوانب السلبية التطبيق ؟

What are the most negative aspects of the application?

8. أي أجزاء التطبيق كانت سهلة الاستخدام؟

Which parts of the application were easy to use?

9. أي أجزاء التطبيق كان من الصعب استخدامها؟

Which parts of the application were difficult to use?

10. هل جعل التطبيق عملية التعلم أكثر متعة؟ أشرحي

Did the application make the learning process more enjoyable? Explain please.

11. هل ساعد النظام التطبيق في عملية التعلم؟ أشرحي

Did the application help in the learning process? Explain please.

12. هل ساعدت الصور في تحسين فهم الكلمات / النصوص؟ أشرحي

Was using pictures technique helpful in enhancing understanding new vocabularies and texts? Explain please.

13. هل وجدت أن ميزات القراءة بصوت عالٍ ساعدت الطلاب على فهم الكلمات / النص؟ أشرحي

هل ساعد استخدام القراءة بصوت مرتفع الطلبة على فهم الكلمات او النصوص؟ اشرحي

Was reading aloud technique effective in enhancing students' understanding of the new vocabularies and texts? Explain please.

14. هل وجدت أن إنشاء القصص ساعد الطلاب على فهم الكلمات العربية بشكل أفضل وتحسين المعرفة؟ أشرحي

Was creating stories technique effective in enhancing student's understanding Arabic vocabularies and enhancing their knowledge? Explain please.

15. هل جعلت مشاركة القصة عملية التعلم أكثر متعة وتعاوناً؟ أشرحني

Did story sharing feature make the learning process more enjoyable and collaborative?

السؤال الختامي

هل تودين التحدث عن أي شيء لم نغطيه في المقابلة؟

Is there anything else you would like to add?

3.5 Researcher observation Notes

Student name:

Students class/ group:

[illegible]

Appendix 4: Ethical Review Requirements for the full study



4.1 Head teacher's consent sheet

Researchers are required to abide by ethical guidelines when working in schools. These cover topics such as gaining appropriate consent, permitting children to withdraw from the study, and keeping data confidential. We would be grateful if you could check and sign the following sheet to show that you approve of the research procedures for this study.

PROJECT NAME

Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

APPROVED BY

University of Sussex Sciences & Technology Cross-Schools Research Ethics Committee
(crecscitec@sussex.ac.uk)

NAME OF RESEARCHER VISITING THE SCHOOL

Sara Alharbi (sa817@sussex.ac.uk)

NAME OF PROJECT SUPERVISORS

Dr. Paul Newbury (P.Newbury@sussex.ac.uk) and Dr. Phil Watten (P.L.Watten@sussex.ac.uk).

PERIOD OF VISITS

Autumn Term 2020

CLASSES/YEAR GROUPS VISITED

Year 2

PROJECT DESCRIPTION

We wish to invite your students to take part in a research study to *interact with* the novel mobile learning app for learning Arabic in primary schools in Saudi Arabia, thus supporting effective and interactive learning within the classroom.

PROCEDURE

It is aimed to run the study with approximately 50 children, their parents/guardians and 5 Arabic language teachers.

- The tablets will be delivered to the parents home address. The tablets will be sanitized before and after students use.
- Observation will be completed using video-based observation via Microsoft Teams, Zoom with a password or other video call applications that the participants are familiar with.
- The pre-post tests will be sent as word document and will be displayed for an appropriate time on the computer screen via sharing the screen through Microsoft Teams, Zoom with a password or other video call applications that the participants are familiar with.
- The questionnaires of both the students and their parents will be online survey through Qualtrics and will be sent to their email or phone numbers.
- Teachers' interviews will be conducted on Microsoft Teams, Zoom with a password or other video call applications that the teachers are familiar with in an appropriate time selected by them.

Study procedure:

Following parental consent, all students will be tested individually before they begin the practical sessions and after to evaluate their reading fluency and comprehension abilities. Each test will be one story (passage) which contains 70 words each and each one is expected to be read for 3 to 5 minutes approximately. The stories (passages) will be a similar version from the stories in the formal book. As students read the passage, the researcher will note the errors on a separate copy of the passage and will mark where the student was at the end of one minute, and also will record the time to read the entire passage.

Immediately following the oral reading test, the passage will be removed and students will be asked to respond orally to five questions from the passages. The researcher will read each question. Questions forms would include who, what, when, where, why, or how questions. All students will learn the same materials but different methods of learning. For the practical sessions, all children will be divided randomly in two groups; control group who will receive no intervention (i.e. will learn with their teacher in virtual classes provided by the ministry of education) and experimental group who will receive the intervention (i.e. tablet).

Each student in the experimental group will attend three sessions distributed into 3 days (i.e. one session per day), each session should last approximately 45 minutes which is equal to the class time. In each session, each child will work individually with a tablet. The system will be accessible via the tablet and enables children to create their own stories by interaction with pictures, words and audio to enable the building and sharing of stories. Each child will be observed while using the system and the researcher will take written notes during the observation process.

Following the three practical sessions, all children will then complete a short questionnaire individually to obtain their perspective on the use of the system.

The Arabic language teachers will also be interviewed before and after the experiment.

A short questionnaire will be sent to the parents/guardians to provide background information relevant to the home literacy environment and the use of technology at home. After the experiment, the system will be given to the teacher and become available to all students in the class.

CONSENT

The researcher will contact the head of schools, during normal opening hours and will explain to them the study goals, the experimental procedure and all information they need. If the head of schools are willing to conduct the study with their school teachers and students, they will forward the researchers' contact details to the teachers to see if they are willing to participate.

The researcher will explain all the required information about the study to the teachers and answer all their questions, providing them with participant information sheets, recruitment letter and consent forms to sign. Teachers' interview will be done through Microsoft Teams, Zoom with a password or other video call applications that the teachers are familiar with.

The parents who have agreed to participate will contact the researcher and will provide their home address in order to deliver the tablets while other study tools will be sent online through their emails.

Teachers will be sent an information letter with details of the study and a consent form to be signed in order to participate in the study. Parents/carers will be sent an information letter with details of the study and a permission form to be signed and returned for them and their child(ren) to participate in the study. Teachers and parents/carers should be given at least one week to read and respond to the letter. Children will be asked for verbal consent to participate in the study after receiving an initial briefing on the nature of the study and the procedures involved. Teachers, children and their Parents/carers will also be given the option to withdraw from the study at any point.



Please sign below to confirm that you:

- Understand the requirements of teachers who take part in the research
- Understand the requirements of children who take part in the research
- Have received detailed descriptions of the methods and materials to be used
- Give approval for the research to take place at your school.

Name of school: _____

Name of [Head Teacher]: _____

Signature: _____

Date: _____



4.2 Teachers consent form

Title of Project: Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

Name of Researcher and School: Sara Bandar D Alharbi. School of Engineering and Informatics.

C-REC Ref no: ER/SA817/4

Please tick box

- | | | |
|---|--------------------------|--------------------------|
| • I consent to being interviewed by the researcher | ☐ | ☐ |
| • I agree to allowing the interview to be audio-recorded. | ☐ | ☐ |
| • I consent to the use of anonymised quotes in publications from the research | ☐ | ☐ |
| • I understand that any information I provide is confidential, and that no information that I disclose will lead to the identification of any individual in the reports on the project, either by the researcher or by any other party | ☐ | ☐ |
| • I have read the information sheet, had the opportunity to ask questions and I understand the principles, procedures and possible risks involved. | ☐ | ☐ |
| • I consent to the processing of my personal information and data for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the General Data Protection Regulation (GDPR) 2016. | ☐ | ☐ |

- I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way nor do I have to give reasons for this. ☐ ☐
- I understand I can request without penalty that my data be withdrawn and deleted even after testing is complete, any time up until the results analysis is complete (01/1/2021). ☐ ☐
- I consent to my data being deposited in the UK Data Archive for re-use in future research and analysis. I understand that it will be fully anonymised before deposit. ☐ ☐
- I agree to take part in the above University of Sussex research project ☐ ☐

Name:

Signature

Date:



4.3 Parents and children consent form

Title of Project: Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

Name of Researcher and School: Sara Bandar D Alharbi, School of Engineering and Informatics

C-REC Ref no: ER/SA817/4

1- Parent Consent for their child

Please tick box

- | | | |
|---|--------------------------|--------------------------|
| • I consent to my child being tested by the researcher | ☐ | ☐ |
| • I consent to my child being observed by the researcher | ☐ | ☐ |
| • I agree to my child completing the questionnaire. | ☐ | ☐ |
| • I understand that the recordings will be stored anonymously, using password-protected software and will be used for specific research purposes. | ☐ | ☐ |

2- Parent Consent for themselves

Please tick box

- | | YES | NO |
|---|--------------------------|--------------------------|
| • I consent to being part of the study. | ☐ | ☐ |

- | | | |
|--|--------------------------|--------------------------|
| • I agree to complete the questionnaire based on my knowledge. | ☐ | ☐ |
| • I consent to the use of anonymised quotes in publications from the research | ☐ | ☐ |
| • I understand that any information I and my child provide is confidential, and that no information that my child disclose will lead to the identification of any individual in the reports on the project, either by the researcher or by any other party | ☐ | ☐ |
| • I have read the information sheet, had the opportunity to ask questions and I understand the principles, procedures and possible risks involved. | ☐ | ☐ |
| • I consent to the processing of my personal information/data and my child personal information/data for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the General Data Protection Regulation (GDPR) 2016. | ☐ | ☐ |
| • I understand that my participation and my child participation are voluntary, that we can choose not to participate in part or all of the project, and that we can withdraw at any stage of the project without being penalised or disadvantaged in any way nor do we have to give reasons for this. | ☐ | ☐ |
| • I understand I can request without penalty that my data and my child's data be withdrawn and deleted even after testing is complete, any time up until the results analysis is complete (01/01/2021). | ☐ | ☐ |
| • I consent to my data and my child data being deposited in the UK Data Archive for re-use in future research and analysis. I understand that it will be fully anonymised before deposit. | ☐ | ☐ |
| • I agree to take part and for my child to take part in the above University of Sussex research project | ☐ | ☐ |

Name of Child -----

**Name of Parent or
Guardian** -----

Age of child -----

Date -----

Signature -----

4.4 Recruitment email for parents

I am a PhD student in the School of Engineering and Informatics at the University of Sussex, and I am conducting research on a mobile learning system aimed at helping children learning to read. The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia. This system allows student to create short stories from existing material which will be provided by the app and then share these stories. This app will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

This study will be completed as part of the Arabic language subject of second year primary schools in Saudi Arabia, and you are receiving this letter as your child is a student who is taking this module. I am looking for participants and would be very grateful if you and your child would be willing to take part in my study. If you agree to do so, you will have the chance to find out more about the study before coming to any decision. You and your child would be under no obligation to take part and this will have no impact on your child's marks, assessments or future studies. It is completely up to you whether to allow your child to participate in this research study.

It of great value to have you and your child participating for the purpose of this research, you will be given a short questionnaire to complete and your child will have the chance to be familiar with new educational tool with the help of me or your child's teacher. The data produced from your and your child's participation will be kept confidential and your names will not be used nor associated with the data in papers, dissertations, or any printed or non-printed volumes associated with this study. The result of this study will be used in my thesis for a PhD degree and also for publication purposes and can be accessed through the university archived theses library and/or published sources.

My research is supervised by Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively. The study will be approved by the Sciences and Technology Cross-Schools Research Ethics Committee (CREC:crecscitec@sussex.ac.uk).

Thank you and Best Regards,

Mrs. Sara Bandar Alharbi
School of Engineering and Informatics
Department of Informatics
University of Sussex
Sa817@sussex.ac.uk

4.5 Recruitment email_ For Teachers

I am a PhD student in the School of Engineering and Informatics at the University of Sussex, and I am conducting research on a mobile learning system aimed at helping children learning to read. The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia. This system allows student to create short stories from existing material which will be provided by the app and then share these stories. This app will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

This study will be completed as part of the Arabic language subject of second year primary schools in Saudi Arabia, and you are receiving this letter as a teacher who is teaching this module. I am looking for participants and would be very grateful if you would be willing to take part in my study. If you agree to do so, you will have the chance to find out more about the study before coming to any decision. You would be under no obligation to take part. It is completely up to you whether to participate in this research study.

It of great value to have you participating for the purpose of this research, you will have the chance to be familiar with new educational tool. Then, you will be interviewed before and after the experiment. The data produced from your participation will be kept confidential and your name will not be used nor associated with the data in papers, dissertations, or any printed or non-printed volumes associated with this study. The result of this study will be used in my thesis for a PhD degree and also for publication purposes and can be accessed through the university archived theses library and/or published sources.

My research is supervised by Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively. The study will be approved by the Sciences and Technology Cross-Schools Research Ethics Committee (CREC:crecscitec@sussex.ac.uk).

Thank you and Best Regards,
Mrs. Sara Bandar Alharbi
School of Engineering and Informatics
Department of Informatics
University of Sussex
Sa817@sussex.ac.uk

4.6 Parents and their children information sheet

PROJECT NAME

Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

INVITATION TO TAKE PART

You and your child are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

What is the purpose of the study?

The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia. This app will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

Why have we been invited to participate?

As a parent who is your child is a student who study the Arabic subject in primary schools in Saudi Arabia. Moreover, we are expecting to test 50 children from year 2 of schools with their parents/guardians. It of great value to have you and your child participating for the purpose of this research.

Do we have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you and your child are still free to withdraw at any time up until the results are analysed (01/1/2021) and without giving a reason. Choosing for your child to either take part or not take part in the study will have no impact on your child's marks, assessments or future studies.

What will happen to us if we take part?

The study will take place online. It is aimed to run the study with approximately 50 children, their parents/guardians and 5 Arabic language teachers. Following parental consent, all

students will be tested individually before they begin the practical sessions and after to evaluate their reading fluency and comprehension abilities. Each test will be one story (passage) which contains 70 words each and each one is expected to be read for 3 to 5 minutes approximately. The stories (passages) will be a similar version from the stories in the formal book. As students read the passage, the researcher will note the errors on a separate copy of the passage and will mark where the student was at the end of one minute, and also will record the time to read the entire passage. Immediately following the oral reading test, the passage will be removed and students will be asked to respond orally to five questions from the passages. The researcher will read each question. Questions forms would include who, what, when, where, why, or how questions. All students will learn the same materials but different methods of learning. For the practical sessions, all children will be divided randomly in two groups; control group who will receive no intervention (i.e. will learn with their teacher in virtual classes provided by the ministry of education) and experimental group who will receive the intervention (i.e. tablet).

Each student in the experimental group will attend three sessions distributed into 3 days (i.e. one session per day), each session should last approximately 45 minutes which is equal to the class time. In each session, each child will work individually with a tablet. The system will be accessible via the tablet and enables children to create their own stories by interaction with pictures, words and audio to enable the building and sharing of stories. Each child will be observed while using the system and the researcher will take written notes during the observation process.

Following the three practical sessions, all children will then complete a short questionnaire individually to obtain their perspective on the use of the system.

The Arabic language teachers will also be interviewed before and after the experiment.

A short questionnaire will be sent to the parents/guardians to provide background information relevant to the home literacy environment and the use of technology at home.

After the experiment, the system will be given to the teacher and become available to all students in the class.

You may review the mobile app content, questionnaires and tests before deciding whether take part.

Notes:

The tablets will be delivered to the parents home address. The tablets will be sanitized before and after students use.

Observation will be completed using video-based observation via Microsoft Teams, Zoom with a password or other video call applications that the participants are familiar with

The pre-post tests will be sent as word document and will be displayed for an appropriate time on the computer screen via sharing the screen through Microsoft Teams, Zoom with a password or other video call applications that the participants are familiar with

The questionnaires of both the students and their parents will be online survey through Qualtrics and will be sent to their email or phone numbers.

What are the possible disadvantages and risks of taking part? (where appropriate)

You will only be required to complete the questionnaire and your child will interact with the tablet and learning materials. This will pose no additional risk to your and your child's safety.

What are the possible benefits of taking part?

Taking part in this study will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

Will our information in this study be kept confidential?

The data you and your child produce during this study will be kept confidential and your name and your child name will not be used nor associated with the data in papers, dissertation, thesis, reports, or any printed or non-printed volumes associated with this study.

What will happen to the results of the research study?

The result of this research will be used in thesis for PhD degree and also for publication purposes. They can be accessed through the university archived thesis and/or published sources.

Who is organising and funding the research?

I am conducting the research as a student at University of Sussex . The organizers of this research are Mrs Sara Alharbi, Dr Paul Newbury, Dr Phil Watten.

Contact for Further Information

For further information on this research you can contact: Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively.

The researcher: Sara Alharbi sa817@sussex.ac.uk

INSURANCE

The University of Sussex has insurance in place to cover its legal liabilities in respect of this study.

THANK YOU FOR TAKING TIME IN READING THIS INFORMATION SHEET

Date

11/09/2020



4.7 Teachers information sheet

PROJECT NAME

Designing a mobile learning application by integrating Universal Design for Learning principles and digital storytelling.

INVITATION TO TAKE PART

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

What is the purpose of the study?

The purpose of this project is to design a novel mobile learning app that uses digital storytelling combined with the principles of Universal Design for Learning (UDL) for teaching Arabic in primary schools in Saudi Arabia.

Why have I been invited to participate?

As a teacher who teach the Arabic subject in primary schools in Saudi Arabia, it of great value to have you participating for the purpose of this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time up until the results are analysed (01/1/2021) and without giving a reason.

What will happen to me if I take part?

If you decide to take part in this study you will be interviewed which will be audio recorded.

What are the possible disadvantages and risks of taking part? (where appropriate)

You will only be required to be interviewed twice during the study, once before using the system and once after using the system. Teachers' interviews will be conducted on Microsoft Teams, Zoom with a password or other video call applications that you are familiar with in an appropriate time selected by you.

This will pose no additional risk to your safety.

What are the possible benefits of taking part?

Taking part in this study will help to shift teacher-centred education to learner-centred education, thus supporting effective and interactive learning within the classroom.

Will my information in this study be kept confidential?

The data you produce during this study will be kept confidential and your name will not be used nor associated with the data in papers, dissertation, thesis, reports, or any printed or non-printed volumes associated with this study.

What should I do if I want to take part?

If you wish to take part in this research please contact Sara Alharbi via emailing her at sa817@sussex.ac.uk

What will happen to the results of the research study?

The result of this research will be used in thesis for PhD degree and also for publication purposes. They can be accessed through the university archived theses and/or published sources.

Who is organising and funding the research?

I am conducting the research as a student at University of Sussex . The organizers of this research are Mrs Sara Alharbi, Dr Paul Newbury, Dr Phil Watten.

Contact for Further Information

For further information on this research you can contact: Dr. Paul Newbury and Dr. Phil Watten and they can be contacted on: P.Newbury@sussex.ac.uk and P.L.Watten@sussex.ac.uk respectively.

The researcher:

Sara Alharbi

sa817@sussex.ac.uk

Chichester 1 room CI 128

INSURANCE

The University of Sussex has insurance in place to cover its legal liabilities in respect of this study.

THANK YOU FOR TAKING TIME IN READING THIS INFORMATION SHEET

Date

13/09/2020

Appendix 5: Full study instruments

5.1 Students' pre test

السِّبَاق

فِي إِحْدَى الْغَابَاتِ الْبَعِيدَةِ كَانَ هُنَاكَ أَرْنَبٌ سَرِيعٌ وَسَلْحَفَةٌ بَاطِيئَةٌ.
 قَالَ الْأَرْنَبُ لِلْسَّلْحَفَةِ: مَا رَأَيْتُكَ أَيُّهَا السَّلْحَفَةُ الْبَاطِيئَةُ أَنْ تَنْسَابِقَ إِلَيَّ الْيَوْمَ؟
 رَدَّتِ السَّلْحَفَةُ: حَسَنًا أَيُّهَا الْأَرْنَبُ الْمَعْرُورُ.
 سَارَتِ السَّلْحَفَةُ بِبُطْءٍ وَصَبْرٍ دُونَ أَنْ تَتَوَقَّفَ.
 قَالَ الْأَرْنَبُ: سَأَنَامُ قَلِيلًا تَحْتَ الشَّجَرَةِ، ثُمَّ أَلْحَقُ بِالسَّلْحَفَةِ الْبَاطِيئَةِ لِأَتْنِي الْأَسْرَعَ.
 اسْتَيْقَظَ الْأَرْنَبُ مَذْعُورًا وَرَاحَ يَرْكُضُ بِسُرْعَةٍ كَبِيرَةٍ، لَكِنَّهُ لَمْ يَلْحَقْ بِالسَّلْحَفَةِ النَّشِيطَةِ الَّتِي
 لَمْ تَتَوَقَّفْ وَفَازَتْ بِالسِّبَاقِ وَ أَخَذَتِ الْجَائِزَةَ الثَّمِينَةَ وَأَصْبَحَتْ سَعِيدَةً.

الأسئلة:

1. ما الشخصيات المذكورة في القصة؟
2. ماذا قال الأرنب للسَّلْحَفَةِ؟
3. لماذا نام الأرنب؟
4. من الذي فاز بالسِّبَاق؟
5. لماذا فازت السَّلْحَفَةُ وخسر الأرنب؟

The Race

In one of the remote forests, there was a fast rabbit and a slow turtle.

The rabbit said to the turtle: What do you think, slow turtle, do we race to the river?

The turtle replied, "Okay, you conceited rabbit."

The turtle went slowly and with patience without stopping.

The rabbit said: I will sleep a little under the tree, and then catch the slow turtle because I am the fastest.

The rabbit woke up terrified and ran away very quickly, but did not catch up with the active turtle that did not stop

She won the race and took the precious prize and became happy.

Questions:

1. What are the characters mentioned in the story?
2. What did the rabbit say to the tortoise?
3. Why did the rabbit sleep?
4. Who won the race?
5. Why did the turtle win and lose the rabbit?

5.2 Students' post test

عَلَمُ بِلَادِي

فِي مَكْتَبَةِ الْمَدْرَسَةِ، كَانَ صَالِحٌ يَرَسُمُ عَلَمَ الْمَمْلَكَةِ الْعَرَبِيَّةِ السُّعُودِيَّةِ وَهُوَ مَسْرُورٌ:

لِيُشَارِكَ فِي مَعْرَاضِ الْيَوْمِ الْوَطَنِيِّ فِي مَدْرَسَتِهِ.

أَحْمَدُ: لَمْ لَا تُلَوِّنِ الْعَلَمَ بِاللَّوْنِ الْأَصْفَرِ؟

صَالِحُ: لَا يُمَكِّنُ يَا أَحْمَدُ، فَعَلَّمُ بِلَادِي لَوْنَهُ أَخْضَرَ.

ثُمَّ أَخْضَرَ صَوْرًا لِأَعْلَامِ دَوْلٍ مُخْتَلِفَةٍ، وَطَلَّبَ مِنْ أَحْمَدٍ أَنْ يُشِيرَ إِلَى عَلَمِ الْمَمْلَكَةِ، فَأَشَارَ إِلَيْهِ بِسُرْعَةٍ.

صَالِحُ: كَيْفَ عَرَفْتَهُ يَا أَحْمَدُ؟

تَبَسَّمَ أَحْمَدُ وَقَالَ: عَرَفْتُهُ بِلَوْنِهِ الْأَخْضَرَ وَكَلِمَةِ التَّوْحِيدِ وَالسَّيْفِ.

ثُمَّ قَالَ: أَنَا أَحِبُّ عَلَمَ بِلَادِي.

الأسئلة:

1. مَنْ الَّذِي كَانَ يَرَسُمُ؟
2. مَاذَا رَسَمَ صَالِحُ؟
3. أَيْنَ سَيُقَامُ مَعْرَاضُ الْيَوْمِ الْوَطَنِيِّ؟
4. كَيْفَ مَيَّزَ أَحْمَدُ عَلَمَ الْمَمْلَكَةِ مِنْ بَيْنِ الْأَعْلَامِ الْأُخْرَى؟
5. مَا لَوْنُ عَلَمِ الْمَمْلَكَةِ الْعَرَبِيَّةِ السُّعُودِيَّةِ؟

My country's flag

In the school library, Saleh was drawing the flag of the Kingdom of Saudi Arabia, and he was pleased: To participate in the National Day exhibition in his school.

Ahmad: Why don't you colour the flag with the yellow colour?

Saleh: It is not possible, Ahmed, because my country flag's colour is green.

Then he brought pictures of the flags of different countries, and asked Ahmed to refer to the flag of the kingdom, and he indicated it quickly.

Saleh: How did you know it, Ahmed?

Ahmed smiled and said: I knew it because of the green colour, the word of monotheism and the sword.

Then he said: I love the flag of my country.

Questions:

1. Who was drawing?
2. What does Saleh draw?
3. Where will the National Day exhibition be held?
4. How does Ahmed distinguish the Kingdom's flag from other flags?
5. What is the color of the flag of the Kingdom of Saudi Arabia?

5.3 Interviews with teachers

1- مقابلة المعلم قبل التجربة

Interviews with teachers before conducting the experiments

الاستخدام العام للتكنولوجيا

General use of technology

1. أخبريني عن طلابك (عمر الطلاب الذين تدرسينهم وعددهم وجنسهم).

Tell us who your students are? (Average number of students, their age group and their gender)?

2. هل تستخدمين التكنولوجيا في الفصل الدراسي الخاص بك؟ ماذا تستخدمين؟ متى تستخدمينه؟ (في اليوم / الأسبوع)

Do you use technology in your classroom? If so, what technology forms or tools do you employ and how often do you use them (on a weekly / daily basis)

3. هل تعتقدين أن التكنولوجيا ستحسن أدائك التدريسي؟ إذا كان الأمر كذلك ، فكيف؟

Do you believe that Technology can improve your ways of teaching? If so, explain how?

4. هل ترغبين باستخدام المزيد من التكنولوجيا في فصلك الدراسي ؟ إذا كان الأمر كذلك فكيف تريدين استخدامها؟

Would you prefer using more technology? if so, how would you like to integrate it?

5. هل يستخدم طلابك التكنولوجيا داخل الفصل الدراسي؟ ماذا يستخدمون؟ كيف يستخدمونها؟ متى يستخدمونها؟ (باليوم / الأسبوع) ما هو دورك خلال هذا الوقت؟

Do your students use technology inside the classroom? What technology tools do they use? When do they use them (on a weekly/ daily basis)? What role do you play while they are using them?

6. هل تعتقدين أن التكنولوجيا ستحفز الطلاب على تعلم القراءة بشكل أفضل؟ إذا كان الأمر كذلك ، فكيف؟

Do you believe that using technology in the classroom can motivate your students to gain reading skills better? If so, how?

7. هل هناك ما يعيق استخدامك التكنولوجيا في الفصل الدراسي؟ إذا كان كذلك، فما هي العوائق ؟

Are there any inhibitors that discourage you from integrating technology in your classroom?

If so, what are these inhibitors?

8. ما هي العوامل المشجعة لاستخدامك التكنولوجيا في الفصل الدراسي؟

What factors can encourage you to use technology in your classroom?

9. هل هناك أي شيء آخر تودين أن تخبريني به عن استخدام التكنولوجيا في فصلك الدراسي؟

Is there anything else I should know about using technology in your classroom?

تعليم اللغة العربية

Arabic Language Teaching

1. ما رأيك في منهج اللغة العربية بشكل عام؟ كيف وجدته؟

What do you think, in general, of the Arabic language curriculum?

2. هل يمكنك أن تخبريني بشكل عام عن موقف الطلاب عندما يحضرون الى فصل اللغة العربية؟

Could you please tell me how your students feel when they attend Arabic language class?

3. ما هي استراتيجيتك في تعليم القراءة؟ لماذا اخترت هذه الاستراتيجيات؟ موجهات: * تفاعلي. * الإملاء.

What strategy do you implement in teaching reading skills? Why did you chose such strategy? Indications: (Interactive, dictation)

4. خلال شرحك للدرس، هل يمكن أن تخبرني بالخطوات الدقيقة التي تتبعينها لتقديم كلمات عربية جديدة للطلاب؟

What are the steps you follow when introducing new Arabic vocabularies to your students?

5. هل يمكن أن تخبريني كيف يتجاوب الطلاب للاستراتيجيات التي تستخدمينها لتعليم اللغة العربية؟ موجهات: * التمتع * التعلم

How do you students interact with the strategies you implement in teaching Arabic language? Indications: (enjoyment, learning).

6. إذا وجد الطالب صعوبة في قراءة أو فهم كلمة جديدة، كيف تساعدني في فهمها واستيعابها؟ موجهات: * مزيد من الشرح * أعطاء بعض الأمثلة.

How do you help your students learn or read a new vocabulary if the face any difficulty? Indications: (giving a further explanation /giving examples).

7. هل تعتقد أن منهج اللغة العربية الحالي يلبي احتياجات الطلاب؟ موجهات: * مناسب لأعمارهم. * يساعد الأطفال * لا يساعد

In your opinion, does the Arabic language curriculum meet your students' need?

Indications: (Suitable for their age group /help them/doesn't help them)

استخدام القصة

Using Storytelling Technique

5. كمعلمة ، هل تستخدم أسلوب سرد القصص في الفصل الدراسي ؟ متى تستخدمينه؟ كيف تستخدمينه؟

As a teacher, do you use the storytelling technique? if so, When and how do you implement it?

6. ما رأيك في استخدام سرد القصص كطريقة لتعليم القراءة؟

What do you think of implementing storytelling technique in teaching Reading skills?

7. هل تعتقد أنه من المهم قراءة القصص في المدرسة؟ إذا كان الأمر كذلك لماذا؟

In your opinion, is reading stories in schools important? If so, why do you think so?

8. هل يمكن أن تخبريني عن مواقف الأطفال عندما تحكي لهم قصة؟ الموجهات: * الاستمتاع * التفاعل

How do your students respond to storytelling? Indications: (Do they enjoy /interact with that?)

السؤال الختامي

هل تودين التحدث عن أي شيء لم نقم بتغطيته في المقابلة؟

Is there anything else you would like to add?

2- مقابلة المعلم بعد التجربة

Interviews with teachers after conducting the experiment

موقف المعلم و إستخدام التطبيق

Teachers' attitudes and the use of the application

3. ما رأيك في التطبيق بشكل عام؟

In general, what do you think of the application?

4. هل تعتقد أن استخدام التطبيق سيساعدك على تحسين أدائك؟ إذا كان الأمر كذلك ، فكيف؟ إذا كانت الإجابة لا ، فلماذا؟

Do you think that using the application can help improving your performance? If so, explain how? If no, why do you think so?

موقف الطلاب

Students' attitudes

4. بعد استخدام النظام ، هل يمكن أن تخبرني بشكل عام عن موقف الطلاب من اللغة العربية؟

After using the application, what are your students' attitudes towards Arabic language learning?

5. وماذا عن موقفهم عند حضور دروس اللغة العربية؟ موجهات: * سعيد * مثير * ممل

How do your students will feel about attending Arabic language classes?

Indications: (happy, excited, bored)

6. هل تعتقد أن استخدام القصص كما هو مطبق في النظام (التطبيق) كوسيلة لعرض وتعليم اللغة العربية يلبي احتياجات الأطفال في هذه المرحلة؟ موجهات: * مناسب لأعمارهم * غير مناسب.

Do you believe that using storytelling, as applied in the application as a way of introducing and teaching Arabic Language. Meet students' needs at this stage?

Indications: (Suitable for their age group or not)

استخدام النظام

Using the application

16. كيف تقيم فعالية التطبيق في تحسين قراءة الطلاب للغة العربية بطلاقة (من 1 إلى 10)؟

On a scale from 1-10, 1 being the lowest and 10 being the highest, how do you rate the effectiveness in improving your students' reading skills?

17. كيف تقيم فعالية هذا التطبيق في تعزيز فهم القراءة لدى الطلاب باللغة العربية (من 1 إلى 10)؟

On a scale from 1-10, 1 being the lowest and 10 being the highest, how do you rate the effectiveness of this application in improving your students' reading comprehension skills?

18. كيف تقيم فعالية هذا التطبيق في تعزيز مشاركة الطلاب في اللغة العربية (من 1 إلى 10)؟

On a scale form 1-10, 1 being the lowest and 10 being the highest, how do you rate the effectiveness of this application in enhancing students' participation in Arabic language classes?

19. كيف تقيم فعالية استخدام الصور في تعزيز فهم الطلاب للكلمات العربية (من 1 إلى 10)؟

On a scale from 1 to 10, 1 being the lowest and 10 being the highest, how do you rate the effectiveness of using pictures in enhancing students' understanding of Arabic vocabularies?

20. كيف تقيمين استخدام القراءة بصوت عالٍ في تعزيز قدرة الطلاب على القراءة باللغة العربية (من 1 إلى 10)؟

On a scale from 1 to 10 , 1 being the lowest and 10 being the highest, how do you rate the effectiveness of using reading aloud technique in enhancing students' reading skills.

21. ما هي أكثر الجوانب إيجابية في التطبيق ؟

What are the most positive aspects of the application?

22. ما هي أكثر الجوانب السلبية التطبيق ؟

What are the most negative aspects of the application?

23. أي أجزاء التطبيق كانت سهلة الاستخدام؟

Which parts of the application were easy to use?

24. أي أجزاء التطبيق كان من الصعب استخدامها؟

Which parts of the application were difficult to use?

25. هل جعل التطبيق عملية التعلم أكثر متعة؟ أشرحي

Did the application make the learning process more enjoyable? Explain please.

26. هل ساعد النظام التطبيق في عملية التعلم؟ أشرحي

Did the application help in the learning process? Explain please.

27. هل ساعدت الصور في تحسين فهم الكلمات / النصوص؟ أشرحي

Was using pictures technique helpful in enhancing understanding new vocabularies and texts? Explain please.

28. هل وجدت أن ميزات القراءة بصوت عالٍ ساعدت الطلاب على فهم الكلمات / النص؟ أشرحي

هل ساعد استخدام القراءة بصوت مرتفع الطلبة على فهم الكلمات او النصوص؟ اشرحي

Was reading aloud technique effective in enhancing students' understanding of the new vocabularies and texts? Explain please.

29. هل وجدت أن إنشاء القصص ساعد الطلاب على فهم الكلمات العربية بشكل أفضل وتحسين المعرفة؟ أشرحي

Was creating stories technique effective in enhancing student's understanding Arabic vocabularies and enhancing their knowledge? Explain please.

30. هل جعلت مشاركة القصة عملية التعلم أكثر متعة وتعاونًا؟ أشرحي

Did story sharing feature make the learning process more enjoyable and collaborative?

السؤال الختامي

هل تودين التحدث عن أي شيء لم نغطيه في المقابلة؟

Is there anything else you would like to add?

5.4 Parent Questionnaire

Your Name: _____	Child name: _____
Relationship to the child _____	Child School/Class: _____

To help provide background information about your child's early literacy and technology experiences, please take a few minutes to fill out the survey. Thank you for your cooperation.

A. Child information:

1. What is the gender of your child:
 - Male.
 - Female.

2. How old is your child?
 - 6 years
 - 7 years
 - 8 years
 - 9 years

3. Does your child has learning disability:
 - Yes
 - No
 - Prefer not to say

4. What does your child reading ability in Arabic:
 - Very fluent
 - Fluent
 - Normal Fluency
 - Not fluent
 - Not fluent all
 - Prefer not to say

B. Technology use:

1. Do you have internet at home:
 - Yes
 - No

2. What type of technology do you own at home?
 - Smartphone
 - Tablet
 - TV
 - Laptop or Desktop
 - Video games
 - Other

(Please specify) _____

3. Which technology devices do you use with your child
 - Smartphone

- Tablet
- TV
- Laptop or Desktop
- Video games
- Other

(Please specify)_____

4. Which devices does your child could use independently:

- Smartphone
- Tablet
- TV
- Laptop or Desktop
- Video games
- Other

(Please specify)_____

5. What is/ are the most preferred technology devices your child enjoys using:

- Smartphone
- Tablet
- TV
- Laptop or Desktop
- Video games
- Other

(Please specify)_____

6. What does your child generally do (activity) on smart phone/tablet devices:

- Reading
- Listening to music
- Drawing
- Playing games
- Browsing the internet
- Other

(Please specify)_____

7. How many hours per day does your child engage in technology use (in weekdays Sunday to Thursday)?

- Not at all
- Less than an hour
- 1-2 hours
- 2-3 hours
- 3-4 hours
- 5 hours or more

How many hours per day does your child engage in technology use (in weekend days Friday and Saturday)?

- Not at all
- Less than an hour
- 1-2 hours
- 2-3 hours

- 3-4 hours
- 5 hours or more

8. How well can your child operate the following devices:

Devices	Does not know	Limited	Adequate	Very Well
Television				
Computer or laptop				
iPad				
Video Game System				
Smart Phone				

9. Does your child operate the mobile/ tablet applications:

- by themselves (alone)
- with help
- not at all.

10. Is your child required to obtain parent permission before using technology?

- Yes always
- Sometimes
- Never

11. Does your child own a device? Please specify the type/ brand:

- Yes
- No

Brand _____

12. In what way(s) does your child use portable technology devices?

- Learning
- Entertainment
- Both

13. When using portable technology for LEARNING, what device(s) does your child use? (*select all that apply*)

- iPad
- iPhone
- Android smartphone
- Galaxy tablet
- Laptop
- Amazon Kindle
- Smartwatch
- Other _____

14. Please share more about how your child uses portable technology applications to learn to read:(optional)

15. When using portable technology for ENTERTAINMENT, what device(s) does your child use? (*select all that apply*)

- ☐ iPad
- ☐ iPhone
- ☐ Android smartphone
- ☐ Galaxy tablet
- ☐ Laptop
- ☐ Amazon Kindle
- ☐ Smartwatch
- ☐ Other _____

16. Please indicate how long your child has been using portable devices:

- Has never used a portable device
- Since age of 2
- Since age of 3
- Since age of 4
- Since age of 5
- Since age of 6
- Since age of 7

C. Home literacy environment

Who is responsible for teaching your child at home:

- Mother
- Father
- Siblings
- Tutor
- No one

17. Do you read with your child:

- Yes
- No

18. How much time do you spend reading with your child each day?

- Less than 30 minutes
- 30 minutes to an hour
- 2 hours
- More than 3 hours

19. How old was your child when you began reading to him/her?

20. How many books your child own?

- Less than 5 books
- 5-10
- 10-15
- 15-20
- More than 20
- None

21. Do you prefer reading stories for your child from a book or stories smartphone/tablet? Why?

- book
- smartphone/tablet

The reason:

22. Does your child prefer stories read from a book or stories on the smartphone/tablet? Why?

- book
- smartphone/tablet

The reason:

23. What would your child prefer reading to use themselves? Why?

- book
- smartphone/tablet

The reason:

24. What do you think about the use of technology at schools:

	Strongly agree	Agree	Natural	Disagree	Strongly disagree
Schools should increase the use of technology in the classroom for teaching and learning reading					
Schools should increase the use of smartphone in classroom for teaching and learning reading					
Schools should increase the use of tablet in the classroom for teaching and learning reading					
Schools should increase the use of laptop in the classroom for teaching and learning reading					

5.5 Post Experiment students' survey

Student name:_____ School:_____

Class:_____

A- Answer the following questions:

Question	Strongly agree 	Agree 	Neutral 	Disagree 	Strongly disagree 
The application is easy to use					
I can read at my own pace					
The content provided enhanced my learning					
Reading on the screen is easy					
The words are easy to read.					
The words are easy to understand.					
Creating the story in the novice level is easy					
Creating the story in the expert level is easy and helps me to use my imagination					
The use of read aloud is easy					
The sounds help me to read the words and sentences					
The sound is clear					
The pictures look good and are easy to understand					
The pictures help me to understand the words and sentences					
Sharing the story is easy					
When I see my friends stories I feel happy and this encourages me to read					
This application has all the functions and capabilities I need					
The application helped improving my reading skills					
This application is useful for creating stories					
Creating my own stories was fun					
I want to use the application for improving my reading skills					

I prefer using the application for increasing my reading ability than using a book					
I enjoyed using the application					
I would like to keep using this application to read					
I learned to read quickly using this application					
I want to play again					
I want to play longer					
I feel I learn more in this application					
I feel motivated to read when I use the application					
I feel engaged when I use the application					
I was happy when I created a story using the application					
I feel happy when I read my story					

B. The researcher will ask each student the following:

1- Which parts of the system were easy to use?

2- Which parts of the system were difficult to use?

5.6 Researcher observation Notes

Student name:

Students class/ group:

[illegible]

Appendix 6: Other statistical analysis

6.1 Mann-Whitney Test

Ranks				
	Group	N	Mean Rank	Sum of Ranks
PreTotalTime_Seconds	Control Group	15	14.60	219.00
	Experimental group	25	24.04	601.00
	Total	40		
Pre_Rate_1min	Control Group	15	28.20	423.00
	Experimental group	25	15.88	397.00
	Total	40		
Pre_WCPM_1min	Control Group	15	27.57	413.50
	Experimental group	25	16.26	406.50
	Total	40		
PreAccuracy_1min	Control Group	15	20.40	306.00
	Experimental group	25	20.56	514.00
	Total	40		
Pre_Rate_3min	Control Group	15	27.57	413.50
	Experimental group	25	16.26	406.50
	Total	40		
Pre_WCPM_3min	Control Group	15	27.37	410.50
	Experimental group	25	16.38	409.50
	Total	40		
PreAccuracy_3min	Control Group	15	22.93	344.00
	Experimental group	25	19.04	476.00
	Total	40		
PreRightAnswer	Control Group	15	19.80	297.00
	Experimental group	25	20.92	523.00
	Total	40		
PreWrongAnswer	Control Group	15	19.80	297.00
	Experimental group	25	20.92	523.00
	Total	40		
PreHalfAnswer	Control Group	15	22.03	330.50
	Experimental group	25	19.58	489.50
	Total	40		

PreTotalRightWords(OutOf70words)	Control Group	15	22.83	342.50
	Experimental group	25	19.10	477.50
	Total	40		
PreTotalWrongWords(OutOf70words)	Control Group	15	19.10	286.50
	Experimental group	25	21.34	533.50
	Total	40		
PostTotalTime_Seconds	Control Group	15	16.83	252.50
	Experimental group	25	22.70	567.50
	Total	40		
Post_Rate_1min	Control Group	15	24.93	374.00
	Experimental group	25	17.84	446.00
	Total	40		
Post_WCPM_1min	Control Group	15	23.57	353.50
	Experimental group	25	18.66	466.50
	Total	40		
PostAccuracy_1min	Control Group	15	13.67	205.00
	Experimental group	25	24.60	615.00
	Total	40		
Post_Rate_3min	Control Group	15	24.40	366.00
	Experimental group	25	18.16	454.00
	Total	40		
Post_WCPM_3min	Control Group	15	23.17	347.50
	Experimental group	25	18.90	472.50
	Total	40		
PostAccuracy_3min	Control Group	15	16.50	247.50
	Experimental group	25	22.90	572.50
	Total	40		
PostRightAnswer	Control Group	15	15.77	236.50
	Experimental group	25	23.34	583.50
	Total	40		
PostWrongAnswer	Control Group	15	23.40	351.00
	Experimental group	25	18.76	469.00
	Total	40		
PostHalfAnswer	Control Group	15	24.17	362.50
	Experimental group	25	18.30	457.50
	Total	40		
PostTotalRightWords(OutOf72words)	Control Group	15	16.43	246.50
	Experimental group	25	22.94	573.50

	Total	40		
PostTotalWrongtWords(OutOf72words)	Control Group	15	24.57	368.50
	Expiremental group	25	18.06	451.50
	Total	40		

Test Statistics ^a		Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)	Exact Sig. [2*(1-tailed Sig.)]	a. Grouping Variable: Group	b. Not corrected for ties.
	PreTotalTime_Seconds	99.000	219.000	-2.472	0.013	.013 ^b		
	Pre_Rate_1min	72.000	397.000	-3.234	0.001	.001 ^b		
	Pre_WCPM_1min	81.500	406.500	-2.971	0.003	.002 ^b		
	PreAccuracy_1min	186.000	306.000	-0.043	0.966	.978 ^b		
	Pre_Rate_3min	81.500	406.500	-2.994	0.003	.002 ^b		
	Pre_WCPM_3min	84.500	409.500	-2.879	0.004	.003 ^b		
	PreAccuracy_3min	151.000	476.000	-1.020	0.308	.319 ^b		
	PreRightAnswer	177.000	297.000	-0.309	0.757	.783 ^b		
	PreWrongAnswer	177.000	297.000	-0.311	0.756	.783 ^b		
	PreHalfAnswer	164.500	489.500	-0.735	0.462	.525 ^b		
	PreTotalRightWords(OutOf70words)	152.500	477.500	-0.980	0.327	.332 ^b		
	PreTotalWrongWords(OutOf70words)	166.500	286.500	-0.588	0.557	.562 ^b		
	PostTotalTime_Seconds	132.500	252.500	-1.537	0.124	.125 ^b		
	Post_Rate_1min	121.000	446.000	-1.861	0.063	.065 ^b		
	Post_WCPM_1min	141.500	466.500	-1.286	0.198	.201 ^b		

	PostAccuracy _1min	85.000	205.000	-2.895	0.004	.004 ^b		
	Post_Rate_3 min	129.000	454.000	-1.652	0.099	.106 ^b		
	Post_WCPM_ 3min	147.500	472.500	-1.118	0.263	.267 ^b		
	PostAccuracy _3min	127.500	247.500	-1.679	0.093	.094 ^b		
	PostRightAns wer	116.500	236.500	-2.108	0.035	.046 ^b		
	PostWrongAn swer	144.000	469.000	-1.406	0.160	.233 ^b		
	PostHalfAnsw er	132.500	457.500	-1.859	0.063	.125 ^b		
	PostTotalRigh tWords(OutOf 72words)	126.500	246.500	-1.706	0.088	.088 ^b		
	PostTotalWro ngtWords(Out Of72words)	126.500	451.500	-1.706	0.088	.088 ^b		

6.2 Wilcoxon Test

Ranks				
		N	Mean Rank	Sum of Ranks
PostTotalTime_Seconds - PreTotalTime_Seconds	Negative Ranks	27 ^a	23.02	621.50
	Positive Ranks	12 ^b	13.21	158.50
	Ties	1 ^c		
	Total	40		
Post_Rate_1min - Pre_Rate_1min	Negative Ranks	10 ^d	12.90	129.00
	Positive Ranks	27 ^e	21.26	574.00
	Ties	3 ^f		
	Total	40		
Post_WCPM_1min - Pre_WCPM_1min	Negative Ranks	12 ^g	14.00	168.00
	Positive Ranks	26 ^h	22.04	573.00
	Ties	2 ⁱ		
	Total	40		
PostAccuracy_1min - PreAccuracy_1min	Negative Ranks	19 ^j	13.89	264.00
	Positive Ranks	14 ^k	21.21	297.00
	Ties	7 ^l		
	Total	40		
Post_Rate_3min - Pre_Rate_3min	Negative Ranks	9 ^m	19.06	171.50
	Positive Ranks	30 ⁿ	20.28	608.50
	Ties	1 ^o		
	Total	40		
Post_WCPM_3min - Pre_WCPM_3min	Negative Ranks	13 ^p	17.08	222.00
	Positive Ranks	26 ^q	21.46	558.00
	Ties	1 ^r		
	Total	40		
PostAccuracy_3min - PreAccuracy_3min	Negative Ranks	16 ^s	17.00	272.00
	Positive Ranks	23 ^t	22.09	508.00
	Ties	1 ^u		
	Total	40		
PostRightAnswer - PreRightAnswer	Negative Ranks	5 ^v	10.50	52.50
	Positive Ranks	20 ^w	13.63	272.50
	Ties	15 ^x		
	Total	40		

PostWrongAnswer - PreWrongAnswer	Negative Ranks	15 ^y	9.33	140.00
	Positive Ranks	3 ^z	10.33	31.00
	Ties	22 ^{aa}		
	Total	40		
PostHalfAnswer - PreHalfAnswer	Negative Ranks	11 ^{ab}	8.50	93.50
	Positive Ranks	5 ^{ac}	8.50	42.50
	Ties	24 ^{ad}		
	Total	40		
PostTotalRightWords(Out Of72words) - PreTotalRightWords(OutO f70words)	Negative Ranks	10 ^{ae}	14.25	142.50
	Positive Ranks	26 ^{af}	20.13	523.50
	Ties	4 ^{ag}		
	Total	40		
PostTotalWrongtWords(O utOf72words) - PreTotalWrongWords(Out Of70words)	Negative Ranks	19 ^{ah}	22.11	420.00
	Positive Ranks	17 ^{ai}	14.47	246.00
	Ties	4 ^{aj}		
	Total	40		
a. PostTotalTime_Seconds < PreTotalTime_Seconds				
b. PostTotalTime_Seconds > PreTotalTime_Seconds				
c. PostTotalTime_Seconds = PreTotalTime_Seconds				
d. Post_Rate_1min < Pre_Rate_1min				
e. Post_Rate_1min > Pre_Rate_1min				
f. Post_Rate_1min = Pre_Rate_1min				
g. Post_WCPM_1min < Pre_WCPM_1min				
h. Post_WCPM_1min > Pre_WCPM_1min				
i. Post_WCPM_1min = Pre_WCPM_1min				
j. PostAccuracy_1min < PreAccuracy_1min				
k. PostAccuracy_1min > PreAccuracy_1min				
l. PostAccuracy_1min = PreAccuracy_1min				
m. Post_Rate_3min < Pre_Rate_3min				
n. Post_Rate_3min > Pre_Rate_3min				
o. Post_Rate_3min = Pre_Rate_3min				
p. Post_WCPM_3min < Pre_WCPM_3min				
q. Post_WCPM_3min > Pre_WCPM_3min				
r. Post_WCPM_3min = Pre_WCPM_3min				
s. PostAccuracy_3min < PreAccuracy_3min				
t. PostAccuracy_3min > PreAccuracy_3min				
u. PostAccuracy_3min = PreAccuracy_3min				
v. PostRightAnswer < PreRightAnswer				
w. PostRightAnswer > PreRightAnswer				

x. PostRightAnswer = PreRightAnswer
y. PostWrongAnswer < PreWrongAnswer
z. PostWrongAnswer > PreWrongAnswer
aa. PostWrongAnswer = PreWrongAnswer
ab. PostHalfAnswer < PreHalfAnswer
ac. PostHalfAnswer > PreHalfAnswer
ad. PostHalfAnswer = PreHalfAnswer
ae. PostTotalRightWords(OutOf72words) < PreTotalRightWords(OutOf70words)
af. PostTotalRightWords(OutOf72words) > PreTotalRightWords(OutOf70words)
ag. PostTotalRightWords(OutOf72words) = PreTotalRightWords(OutOf70words)
ah. PostTotalWrongWords(OutOf72words) < PreTotalWrongWords(OutOf70words)
ai. PostTotalWrongWords(OutOf72words) > PreTotalWrongWords(OutOf70words)
aj. PostTotalWrongWords(OutOf72words) = PreTotalWrongWords(OutOf70words)

Test Statistics ^a		Z	Asymp. Sig. (2-tailed)	a. Wilcoxon Signed Ranks Test	b. Based on positive ranks.	c. Based on negative ranks.
	PostTotalTime_Seconds - PreTotalTime_Seconds	- 3.231 ^b	0.001			
	Post_Rate_1min - Pre_Rate_1min	- 3.364 ^c	0.001			
	Post_WCPM_1min - Pre_WCPM_1min	- 2.945 ^c	0.003			
	PostAccuracy_1min - PreAccuracy_1min	-.295 ^c	0.768			
	Post_Rate_3min - Pre_Rate_3min	- 3.067 ^c	0.002			
	Post_WCPM_3min - Pre_WCPM_3min	- 2.346 ^c	0.019			
	PostAccuracy_3min - PreAccuracy_3min	- 1.647 ^c	0.100			

	PostRightAnswer - PreRightAnswer	- 3.157 ^c	0.002			
	PostWrongAnswer - PreWrongAnswer	- 2.514 ^b	0.012			
	PostHalfAnswer - PreHalfAnswer	- 1.500 ^b	0.134			
	PostTotalRightWords(OutOf72words) - PreTotalRightWords(OutOf70words)	- 2.999 ^c	0.003			
	PostTotalWrongWords(OutOf72words) - PreTotalWrongWords(OutOf70words)	- 1.370 ^b	0.171			