Mobile Technology and Islamic Education for Non-Native Arabic Children

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Dedication

I would like to dedicate this thesis to:

- To My Mum,
- To The Soul of My Dad,
- To my Only Brother,
- To my Only Sister,
- To My Lovely Children, Handsome “Wesam” and Beautiful “Talleen”
- & To My Lovely Husband.

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Statement Of Authentication

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in full or in part, for a degree at this or any other institution.

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Publications

1. Reviewing Mobile Apps for Learning Quran (1).
2. Quranic Education and Technology: Reinforcement learning System for Non-Native Arabic Children (2).
3. Testing of Reinforcement learning System in Quranic Education for Non-Native Arabic Children (3).

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Abstract

Most religions practised at present are grounded in deep history and tradition. Sculptures and writings have been passed on from generations and are integral to the sanctity of the religion. In addition, the use of digital technology can provide us with a mechanism to not only maintain the consistency of the teaching but also establish a real-time learning and understanding process for a variety of users. Islam is one of the largest religions in the world with almost 1/5th of the world's population being of the Muslim faith. The Qur'an is the holy book for millions of Muslims around the world and is read and learnt in the Arabic language.

This thesis aims to provide a strong technology base to improve the teaching experience for school teachers and religious scholars in regard to educating non-native Arabic children about the holy book, the Qur'an, as well as improving the progress curve for those children by proving a strong technology base which addresses their circumstances. It should be noted that there was no prior knowledge about those children and their difficulties caused by language, background, and cultural barriers in relation to their learning abilities.

In this thesis, we build a web simulator based on a reinforcement learning mechanism and use a Speech recognition system to achieve our intended goal. Unlike other studies, this research is build based on a User Centre Design where data was collected from both types of instructors, being school teachers and

religious scholars, to help build the system. After the system was built, we used the same type of instructors to examine the system before they actually implemented it on children.

Thus, this research has been completed through the use of three studies: a qualitative study with school teachers and religious scholars to collect data about what the design should address, a qualitative study on both types of teachers to examine the system, and finally, a quantitative study completed by teachers on the use of the system by children.

The results found were extremely positive in terms of providing teachers with a system which is cable to support and improve their teaching experience as well as ensuring an incredible improvement of children's' performance in their Islamic education.

Chapter 1

Introduction

1.1 The Holy Qur'an and Technology

Deep History and tradition are the main grounds for most currently practiced religions. Nowadays, digital technology is optimized and capable in providing a mechanism to establish real-time learning and understanding of different types of users, while also maintaining consistency. Further, 1/5 of the world's population is of the Muslim faith, which makes Islam one of the largest religions in the world today.

The Qur'an is the holy book for millions of Muslims around the world and is read and learnt in the Arabic language (5). While the implementation of Qur'anic education differs, the rules and practising related to reading the Qur'an remain the same, as detailed in section 2.1 of this thesis.

Lately, research indicates that there is a recent adaptation of Islam and technology. Advancements in Arabic speech recognition have allowed for checks and verifications of *tajweed* (6), i.e. pronunciation of verses from

the Qur'an (7, 8). Slowly, in schools, colleges and universities based in the Muslim world, Islamic education is being supplemented with novel forms of technology (9, 10). It contributes to the proliferation of everyday technology in the developing world and is used to teach languages (11) such as Arabic (12). Therefore, there lies a great potential in utilising mobile computing technology to promote Qur'anic education (13), particularly for non-native speakers of Arabic. It is considered that mobile versions of the Qur'an can provide portability and accessibility in comparison to only having access to the physical copy of the Qur'an - "Mushaf" (14), and as a result we see a number of new systems being introduced to the market. The aim of this work was to perform a review of existing Islamic religion-based commercial applications in the market, to further understand the gaps, trends, learning styles and user preferences of learners. It was very important to understand the importance of using mobile technology for such purposes. We contribute towards educational technology literature by providing design implications extracted from our review, which are, firstly, relevant to systems aimed to teach the Qur'an. However, some findings can be generalised and applied to other religious systems also. In sum, to the best of our knowledge, we believe our study is one of the first to explore the potential use of technology for Qur'anic education through qualitative discussions with two groups of instructors, namely school teachers and religious scholars.

1.2 Key Research Issues and Major Contributions

Through the literature review, we confirm the need for an educational technology that is able to serve non-Arabic native speakers from the age group between 4 and 7 years old. That technology must be cognitively active, deeply engaging, meaningful, able to attract children, and make them more creative, while giving them some responsibility to customize and apply their own settings.

Qur'anic education is generally taught to children in schools or mosque groups. Collaborative learning as defined below is a real challenge for this type of education. The next bullets show how we build the research question and which fact it is based on.

Accordingly, in this thesis, we investigate the following: Collaborative learning, as defined in (15), causes significant impact on students as they defined collaborative learning as one or group of students in a group or a room interacting using Internet connection. Therefore, collaborative learning is a challenge when it comes to children with different backgrounds learning the Qur'an as Arabic may not be their first language.

Thus, creating a system that is able to provide a competitive environment and allow for a fair response and interactions for everyone is a significant part of the system. Our first research question is:

1. What learning mechanism is to be used to provide a fair response and

interactions for children to understand their weaknesses and strengths where there is no prior knowledge about the children, especially in relation to the Qur'anic education for non-native speaking Arabic children?

Children's interactions with the different models in (16), including face to face, videoconference,and avatar, reveal interesting results that some children accept face to face modes or the use of avatar while others reject using avatars. Similarly, in (17), we understand that a new variable may increase the strength in the relationship between a child and the system such as allowing children to select an avatar to demonstrate them in a virtual classroom. Thus, we formulate the following research questions:

2. What combination in a system between avatar and the teacher will provoke a proper reaction from students, especially if we agreed that some are in favour of using avatars and some prefer the teacher?

Scholars and teachers argue that children with varying barriers due to their backgrounds, act differently in a classroom, as a result of cultural and language difficulties that they face. Different children respond to different verses of the Quran in different ways. For example, one verse that seems very easy for one child could be extremely hard for another child; however, teachers need to understand this. Finally, the above analysis raises the following research question:

3. What are the characteristics of breaking down a verse into seperate

chunks, such that the system is able to identify children's learning difficulties?

Accordingly, this research will contribute the following:

1. We studied the importance of the usage for the current mobile technologies; then, we interviewed scholars and Islamic teachers to find the relation between children and devices in everyday use. We also investigated the difficulties teachers face from children and the difficulties children face when learning the Qur'an, as per their current practices.

2. In correspondence to the first problem, we built a system based on a speech recognition system that was fed by a reinforcement learning mechanism. Such that, while reinforcement learning is used to build training data about the child, an examination is conducted to investigate the child's weaknesses and strengths and therefore responds accordingly to improve areas of weaknesses that may cause a significant improvement curve.

3. In correspondence to the second problem, an avatar selection was used to demonstrate and simulate the presence of a child in a classroom. In addition to this, the avatar mouth movement interaction would be available when help is needed by the student, and teacher's involvement can also be connected at any point when necessary.

4. In correspondence to the third problem, three static examination maps will be conducted to examine the child and build knowledge. However, these maps contain only chunks from Noraniah Qaidah.

1.3 Research Map & Aims

In this thesis, as shown in Figure 1.1, we start off by conducting a study about the importance of technologies and Islamic education represented in Chapter 3 and outline the significance of mobile technologies and their Apps. Then, we identify our method for this study in Chapter 4 and collect data from both types of instructors, school teachers and religious scholars in our **Qualitative Study 1**, where details can be found in Chapter 5. Then, we design the system and implement the prototype in Chapter 6. The evaluation phase is found in chapter 7 which consist of 3 blocks, namely, round 1 testing, which collects feedback from both types of instructors in our **Quantitative Study 2** and improves the system based on the data collected in testing round 1. Lastly, round 2 of testing is conducted where teachers tried the system on children to examine its features in our **Quantitative Study 1**.

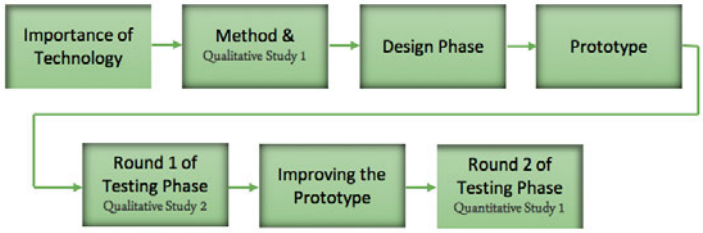

Figure 1.1: Research Map

1.4 Dissertation Organisation

This thesis is organised as follows: Chapter 2 provides some literature review and background information, while Chapter 3 provides a review on mobile Apps for Learning the Qur'an. Chapter 4 shows in detail the research methodology, while Chapter 5 shows the data collected from both types of instructors to build the system. Chapter 6 discusses and shows a description of the design and the implemented system. Two rounds of testing occur to verify the validity of the system shown in Chapter 7, and finally the conclusion is described in Chapter 8.

Chapter 2

Literature Review and Background

2.1 Background

Qur'anic education and Islamic education are two types of studies; however, Qur'anic education, in general, is considered to be a part of Islamic education.

1. *tajweed*: The applied or conventional definition of *tajweed* is "Articulating every letter from its articulation point *[makhraj]* and giving the letter its rights and dues. The rights of a letter is its intrinsic and necessary characteristics [sifat] that always accompany it, such as the imprisonment of running on of breath *[jahr]*, imprisonment of the running of the sound [shidda], directing pressure of the letter to the roof of the mouth [isti'la'], or the absence thereof [istifal] and the nasal sound [ghunna]. The dues of a letter are its extrinsic and contingent characteristics arising from the intrinsic characteristics such

as the heaviness [tafkhim] or lightness [tarqiq] that enters the body of the letter" (18). In summary, Tajweed refers to the correct elocution, pronunciation of Qur'anic verses with a suitable speed of articulation (19). Any mobile technology which focused on this learning style was placed into this category.

2. *tafseer*: Tafseer is referred to as the science of the mode of articulating the expressions of the Qur'an, its linguistic indications and singular and composite rules, its meanings interpreted as composite constructions and related matters (20). Mobile technologies dealing with the semantics were, hence, placed into this category.

3. *hifz*: A mobile technology that employed Hifiz as its mode of teaching concentrates on the memorisation of Qur'anic verses by the heart through repeated recitations (21).

4. *Noorani Qaida*: The Noordani Qaida is a teaching method for the Qur'an that explains the basic pronunciations of various phonemes. It is typically intended for children or for those who are beginning to learn the Qur'an.

5. General: A mobile technology was placed into this category if it uses two or more of the aforementioned pedagogical techniques in combination.

The study aims to bring the actual challenges and difficulties faced within the classroom to allow us to design a system capable to overcome

these difficulties and to improve the teaching experience for our target critical age group of children who are non-native Arabic speakers. The testing phase aims to evaluate the system and ensure the satisfaction of its requirements. On one hand, its main concern is to check how difficulties in which teachers may face can be overcome in an actual class. On the other hand, it focuses on checking that the system works as it should with children. This research follows the User-Centred Design to enable the use of data collected by scholars and teachers to build the system. Two rounds of testing are then taken to check and optimise the system as described earlier in Figure 4.1.

In summary, this research aims to achieve the following:

- Improve teaching experience for both types of instructors, namely school teachers and religious scholars.
- In qualitative study 1 in Appendix A, we aim to outline the challenges and difficulties needed to be overcome within the design phase.
- In the design phase, we aim to fit both types of instructors' requirements into the system.
- In the evaluation phase, qualitative study 2 in Appendix B aims to collect feedback from both types of instructors to ensure satisfaction about the design and obtain some recommendations to improve the system.
- In the evaluation phase, quantitative study 1 in Appendix C aims to

allow teachers to examine the system on children and obtain information to validate the system.

The entire user research mentioned above with all studies made with participants was supported by the Western Sydney University ethical process with approval number H12880 which can be found in Appendix A.

2.2 Literature Review

During the last few decades, many technologies were introduced and become handy for all people regardless their ages. Mobile applications have become the most used technology due to the availability of mobile technology for all ages. Other technologies such as gaming and game theories, blended learning, and mobile technology have been applied in to a classroom for teaching children. However, this study focuses on providing technology for teaching Islam and religion, for teaching Qur'an to non-Arabic native children in particular. In the following subsections, we study some of the currently available techniques and methods used for teaching children religion, and Islamic education.

The use of digital technology can provide us with a mechanism to not only maintain the consistency of teaching religion, but also provides a real-time learning and understanding process for a variety of its users. With the growth in the use of smartphones, mobile apps are now being utilised in the teaching of religion (22). A seminal overview (23) of such apps shows that search terms related to Islam and Christianity resulted in more

than 3000 hits on iTunes. This clearly shows that there is a wide interest and endeavour in learning religions and disseminating information about religions through mobile apps. Furthermore, the same review showed that the common themes of such apps were related to religious content, rituals and practices although it is not immediately clear how many were directly linked to teaching Qur'an or how many were being used as part of the official curriculum in either Madrassah's or Islamic schools.

State of the art research shows that there is recent intersection of Islam and technology. In today's age of multimedia and ICT, a number of research ventures are being undertaken to promote learning and reading of the Qur'an through digitisation - one overview being (24). Interfaces employed to teach Arabic and consequently the Qur'an extend beyond web and mobile platforms, with games and interactive systems also used (25), although such ventures are few and far in between (26, 27). Advancements in Arabic speech recognition have allowed checks and verification of Tajweed (6), i.e. pronunciation of verses from the Qur'an (7, 8). Slowly, in schools, colleges and universities based in the Muslim world, Islamic education is supplemented with novel forms of technology (9, 10). We can observe the proliferation of mobile apps in the developing world and the uptake of the same to teach languages (11) such as Arabic (12), where emerging technologies are utilised to learn words and expression in second languages. It is contemplated that mobile versions of the Qur'an can provide portability and accessibility in comparison to the physical copy of the Qur'an - "Mushaf" (14) as a result of which we see a number of apps being introduced in the

market. Therefore, we believe therein lies great potential in utilising mobile and computing technology to promote Qur'anic education (13), leveraging from the possibility of providing interactivity and profiling to students. As mentioned prior, varying levels of technology are being employed in the afore-mentioned setups within Islamic and Qur'anic education; however, the penetration, role and acceptance of mobile or advanced technology in such settings are relatively unclear. In particular, the study of religion and its open intermingling with technology is a sensitive debate (28), particularly with the combination of Islam and technology (14) as there is a threat of unintentional errors being introduced in the interaction, thereby compromising the sanctity of the religious script. It is also not immediately transparent or realized whether religious scholars or Islamic school teachers are involved in the design of (mobile) technology for Qur'anic education. Ideally, the developmental process of technology for Islamic Education should involve religious scholars and/or Islamic school teachers as the importance of accreditation and standardisation of digital Qur'anic solutions has been highlighted (24). Involving religious experts and recognised Islamic scholars in the technology creation process as a trust building mechanism via a user-centred design process will also ultimately address the issues of acceptance and pessimistic attitudes (29, 30) towards the intermingling of Islam and technology. Our long-term goal is to provide and promote user-centred technological solutions for reading the Qur'an in Islamic institutions with a focus on not only improving the learning experience of children and students, but also in assisting the scholars and teachers in managing the

learning process. It is commonly acknowledged that most digital solutions which are used to learn and read the Qur'an are tailored to Arabic speakers (31) and that non-Arabic speaking users may find it difficult to interpret the deeper (contextual) meanings of the Holy Qur'an (32). Research from other religions also indicate that providing multilingual support to students of religion is imperative (33).

As the first step in our long-term vision, we have carried out user research and requirements for technology-based Qur'anic education; this elicited a qualitative study with scholars and primary school Qur'an teachers, as show in the Qualitative Study 1 based on the research map and aims section, as we believe this is a current gap in current Islamic education literature. By understanding current lesson structures and practices, challenges faced by students and teachers alike and the potential acceptance, use and incorporation of technology in such a setting, we can better design and develop interactive technology for assisting in reading the Qur'an. It is pertinent to mention that, initially, we have not liaised with students, as due to the sanctity and sensitivity of the script and teaching material, we believe that only a recognized and accredited individual can best guide us regarding the design and development of technology for reading the Qur'an. Prior literature also indicates that requirements of educational technology can be acquired by liaising with teachers in the first instance (34).

In sum, to the best of our knowledge, we believe our study is one of the first to explore the potential of technology for Qur'anic education through qualitative discussions with two groups of instructors, namely school teach-

ers and religious scholars.

2.2.1 Technology Vs. Religious and Islamic Learning

Children's engagement with educational iPad apps: Insights from a Spanish classroom was discussed in detail in (35). In this study, the target group was 4-5 years old to allow them to make up stories through a story-making App. It is important to mention the worldwide agreement on iPads and their Apps significant impact on children. On one hand, the authors measure the educational value of iPad and its application as well as children's engagement with educational technology. On the other hand, the study has a "dual focus on children's collaborative verbal engagement with their peers as well as their hands-on individual engagement with the software which allowed us to achieve insights into children's engagement with iPad app-mediated activities and be able to evaluate these in light of the apps' features, content and learning tasks" (35). As their conclusion, taking into consideration the increasing number of educational Apps available and the variety of learning activities provided by Apps, "the time to start considering how to harness this media as a powerful educational tool is now" (35). We believe this is to confirm that the target group for our study is from 4 year old's and onward.

As expected, due to the wide use of iPads and their Apps, education Apps were also provided and made available for young children with disabilities (36). Principles of universal design for instruction related to de-

velopmental domains were shown in a table that presents an emphasis on having the content available in multimedia, multi-language including the child primary language, and as an interactive presentation. This study also provides a guide for evaluating educational apps for use in early childhood education which can be considered. We believe this is to confirm that the more attractive an App is to a child, the more attracted they will become. In fact, authors in (37) discuss putting education in educational Apps. According to their study, 80,000 educational Apps were made available by January 2015. Wild testing and comparison between Apps and approaches have been investigated, but the final results and conclusion were as expected. We are in the first wave of development of Apps, such that existing Apps are just a wonderful combination of games and learning scenarios which already exists in non-digital methods and forms. An interesting question has been addressed stating "how can we foster digital experiences that are cognitively active, deeply engaging, meaningful, and socially interactive within the context of a learning goal?" (37). One suggestion is to take a proactive approach to educational Apps development and evaluation.

A classification framework presented in (38) showed that 20,000 educational Apps were made available by 2012. Authors in (37) discuss putting education in educational Apps. According to their study, 80,000 educational Apps were made available by January 2015. We notice that the number of Apps increased as much as four times in three years' time which indicates the high usage of mobile Apps and their important role in everyday life. An interesting study investigates learning Apps and children and found some

significant results. Around 60% of children used an iPhone in the car, 40% use it at home, while around 35% use it while waiting in general or traveling. Almost 80% of children use the phone for either Apps, pictures, or calling, as researchers (39) believe that using iPads is enjoyable and motivational for both Students and Primary school teachers. Interestingly, a classification framework presented in (38) showed that 20,000 educational Apps were made available by 2012. Just by comparing the previous study, we found that the number of applications increased four times this number in three years or less while the learning goal was not yet achieved as mentioned before. In their framework, the main focus was on the purpose, content, and value of the educational Apps to be selected by teachers.

Authors in (4) discuss the details of educational Apps: using mobile applications to enhance student learning of statistical concepts. The most interesting part is presented in Figure 2.1, where an integrative conceptual model of learning is shown and emphasises technology-assisted learning tools which focus on design and technology mechanisms to produce learning style, engagement, and motivation for the learner.

Another study (40) indicates the importance of educational Apps and shows that over 15 billion downloads on Apps were done by 2012 by teachers, parents, and students where the main focus was paid Apps in this study. In their methodology, they divide the target group into three groups: (0-5), (5-13), (13 plus) year olds. One of the ten subjects considered is a foreign language. They found that 23% of Apps were designed for the first group, 25% for the second group, and 38% was designed for the multi-

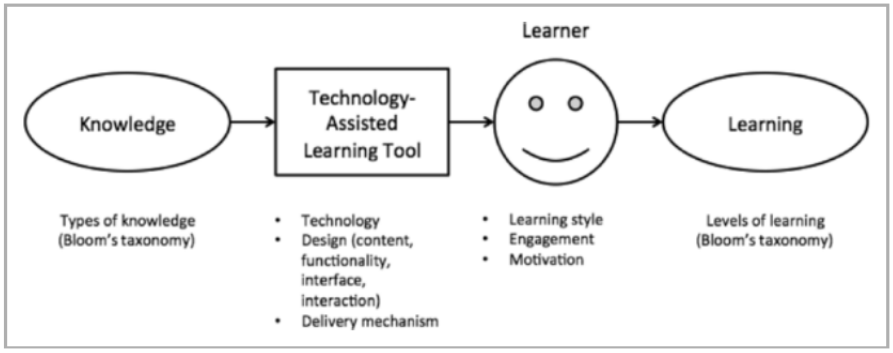

Figure 2.1: Integrated View of Technology-Assisted Learning (4)

age group. The research findings were as follows: first, it is difficult for parents and teachers to easily access educational content. Secondly, the available application is considered limited in terms of being manipulable or constructive. Finally, examining children of use for Apps required further investigation and analysis.

An important study (41) shows that pesante, which is an Islamic Boarding School, intends to transform from being a religious school to be a part of the educational system. The study focuses on how young students may react when using technologies in their language learning. A phenomenological approach was used in this study which allows children to attend solid theories from the field with the focus of teaching Arabic for non-native Arabic speakers. As a result, the study proves that technologies took a significant role in developing young students and gave them a better understanding of the achievement process. Blended learning (42) was widely used as a technology in teaching young students. This study has been expanded in K-12 to show the performance effectiveness of children. One study (43)

investigates the impact of blended learning on students and teachers. It shows the benefits of blended and online learning for students. Blended language learning: research and practice (44) shows the fact that blended learning is a method used for transformation between two different systems. Similarly, a multimedia e-learning-based approach was developed in (45) to help Japanese to learn Arabic. In their product, they focus on producing a listening and watching the product.

In conclusion, we believe that the use of technologies should be meticulously customized especially with today's technologies and children of a specific age. It is very important to emphasise that we are in need to ensure the provided technology is accurately achieving the target goal.

Gaming and the game theory are an important methods used in learning and an important concept to be considered in teaching, especially in our target age group. Gaming was used in the health professional field (46). The study was conducted to measure the behaviour and outcome of the patients and professionals as well. However, the author concludes that the games are useless in such a field. As we believe, this is due to the age of participants as well as its presentation. The latest evidence of game-based learning strategies was discussed in (47). Seminal work (48) conducted on children for cooperation teaching shows some promising results. Important findings show the strong relation between video games and learning in a classroom (49).

Furthermore, mobile game-based learning proved that students using a mobile game gain more knowledge and are more engaged than others

who depend on project-based instructions (50). Their concept and study emphasise the importance of using mobile technology to deliver learning materials. Seminal work (51) attempts to use social networking such as Facebook for teaching while other researchers use mobile phones for teaching Kindergarten students realistic mathematics. Another study (52) discusses the concept of mobile learning (M-learning) in terms of whether the mobile phone is accepted in teaching and learning. The study confirms the positive attitudes towards the use of mobile phones for religious learning purposes. It also confirms that religion teachers are in favour of using mobile learning and they actually use it. Even more, the results show that they are ready and prepared to apply it to their students.

To conclude, it is very important to indicate that an attractive method is needed for our target group as a key concept to make them in favour of our product. Game and mobile-based technology is an important aspect in nowadays technology especially in teaching, but how it would be considered in Islamic teaching is an issue to be considered.

Religion and emerging technologies have been investigated in different countries by different authors such as (28, 41); also, different technologies have been used for different purposes, such as blended learning, and mobile Apps. Religion and emerging technologies in Zimbabwe: contesting for space is a study conducted by (28) and it confirms that the religious media technology has responded very well in a particular instance such as in Zimbabwe. Authors believe that there is no need to compete for religion with science and make a recommendation of studying the relationship between

religion and wealth which is out of the scoop. However, we may consider particular instances and culture such as having easy access to computers and methods of learning as they become harder in some societies while the ease of using mobile phones and applications is considerably confidante wherever possible.

Emerging technologies from memory palaces to spacing algorithms: approaches to second-language vocabulary learning was introduced by (53). The authors provide different ways to help in memorizing words and expressions, which is an important matter in our research. The magical question is how to provide a method for a non-native Arabic speaker to learn Qur'an through mobile Apps. One year later, the same authors provide a study on Mobile apps for language learning (54).

Smartphones and tablets have become interestingly and increasingly important in our daily life. They are capable of accessing the information on the Internet, connecting users all over the world, and consists of a set of Apps that make it easy and convenient for users to access their own data. Importantly, with the growth in using those devices, mobile Apps have become a significant element in teaching matters, including religion. Thus, mobile apps have been increasingly utilized in religious teaching. As excepted, the age group that used religious Apps is over 60 years old (22). We believe this happens due to a lack of religious Apps for younger age groups such as children.

Seminal work such as (23) shows more than 3000 hits in 2014 on iTunes searching for Islamic and Christianity Apps, which indicates and proves that

there is a wide interest in learning religions through mobile Apps. Mostly, the results show that the search was mainly related to religious content and practice, but unfortunately, were not clear how many were related to Qur'an. In 2013, there were 700 Apps offering Qur'an stories for children. Qur'an Apps exist, but targeting children is not an easy task, especially non-native Arabic speakers. As mentioned, non-native Arabic speakers are an important group to be considered and it is interesting for researchers such as (55).

Digitization was used to promote reading and learning of the Qur'an in today's age multimedia and ICT. An overview describing all these related works was is found in (24). On the other hand, games and interactive systems were also been used as a tool to teach Arabic and Qur'an which shows the modalities employed for teaching in this matter (25). In the same study, deaf children were also targeted for Qur'an teaching, which indicates the importance of both the target group and mobile technology. In their conclusion, the authors show that feedback and interaction techniques make children find content more interesting.

A survey was introduced by (56), but it does not provide an overview of pedagogical or Qur'anic recitation methodologies associated with the Qur'an's learning. One important research was provided by (57) with the main focus on web solutions to teach Qur'an. We believe that meta-level understanding and analysis for the existing mobile Apps are important to be present. However, to the best of our knowledge, such an overview does not exist. Challenges in Islamic education and technology can be summarised

as followed:

- Automatic Speech Recognition: It is important to ensure that our product contains some speech recognition technology in order to ensure that the child is doing things correctly and in the right way. We need to study the current speech recognition systems used in learning. The capabilities of computers for language learning were discussed in (58). Few systems have been discussed in detail such as Computer Assisted Language Learning (CALL), and software tools such as Daedalus, Multimedia Authoring Software, and Word Processing Software.

- Arabic Language Complication: an important study in Arabic natural language processing: challenges and solutions were produced in (59). The author points out the challenges of Arabic letters in terms of their pronunciation and shapes. They argue some challenges and some solutions are to be considered such as the change of the letter shape that depends on the letter position in a word. Finally, the author in (60) accents the importance of using multimedia and interactive methods in terms of motivating the learner.

2.2.2 Reinforcement Learning In Qur'anic Education

In the Qur'anic education system, the system must be able to improve its pedagogical policy, sequencing the system's content in an accurate way

according to the current student's needs based only on the student's performance, lesson objectives and the relationships among course modules.

To provide these capabilities in an education system, reinforcement learning has been widely used in the literature (61, 62, 63, 64, 65); however, to the best of our knowledge, this is the first research that uses reinforcement learning for evaluating non-native Arabic children for Qur'anic education. Further details will be discussed in Chapter 6, section 6.5.2.2.

2.2.3 Web-Based learning in Islamic education

Persuasive Model WBL-IE has been designed using the Delphi technique in (66). It focuses on Islamic education and emphases how persuasive technology can be effective in positive behaviours and attitude changes as websites are a very important medium to facilitate online learning. Similarly, (67) attempts to provide a virtual simulator to teach middle school student Hajj, which is the fifth pillar of Islam. Furthermore, another study (68) attempts to develop a web system to help in Qur'an memorization through a set of activities and tests. A web-based interface has been designed in (69) to calculate phonotactic probability in the Arabic language.

The area of teaching Qur'an for non-native Arabic people is important and needs significant improvement (70), especially with children. An e-learning system needs to be developed to tackle the issue, especially when we focus on children aged from 4 to 7 years old.

Finally, mediated Arabic language learning for Arabic students of higher

education in the COVID-19 situation was proposed in (71). In similar circumstances, we assume the pandemic puts non-native Arabic children in higher risky situations. Limitations and difficulties exist, and need more attention in such a circumstance. The limitations of reading to young children in literary Arabic in terms of the unspoken struggle with Arabic Diglossia has been detailed in (72). In general, this was the first research address the challenges of reading to children in a language with Arabic Diglossia. One of the most interesting limitation is that translating during reading does not support reading on rhymes. For instance, teaching Nooraniah Qaida against complete verses could be significantly beneficial. Finally, Noorani Qaida is simply defined as a series of book for learning the Qur'an in Arabic. The results of the previous study confirm that Noorani Qaida has a positive impact and attitude on non-native Arabic children (73). According to the same study, the Arabic language is a very complicated language. Thus, even though we try to get a single character/ phoneme to first rather than to full verses, we believe this is the best to do with non-native Arabic children as confirmed in (73).

In summary, we learn the following from the literature review :

- Most applications and technologies are meant for commercial purposes, without taking the real challenges faced by religious scholars and school teachers.
- We understand that repeating the whole verse is difficult in improving children's learning during the learning process.

- Time consumption to evaluate students accurately within large class settings is a significant issue.
- All existing technologies which are being used, do not take into account the student difficulties which can vary from one to another. Interestingly, we have no prior knowledge about students barriers also. Reinforcement Learning is a valuable tool to accommodate for these difficulties.
- Technologies including phones, Ipads, and tablets, become a dominating factor in learning, and they must be used to improve students performance and teaching experience.

Chapter 3

Mobile Apps for Learning Qur'an: Android Vs. Apple

The Qur'an is the holy book for millions of Muslims around the world and is read and learnt in Arabic. With the advent of technology, we are witnessing a spawning of many mobile apps claiming to provide a digitised experience of Learning the Qur'an. In our research, we present a thorough review of 37 such apps from the Google Play Store and a review of 85 apps from the IOS Apple Store. Our results show that while most apps provide tailored interaction, the main target group remains as adult Arabic speaking users. Moreover, real-time feedback remains a sought after feature in these apps, due to limitations in speech recognition. Accreditation and authentication of the sanctity of these apps and the information presented therein, remain a key worry for most users. In conclusion, we present design implications emerging from our results that could be applied to mobile apps for Qur'anic teaching.

3.1 Introduction

Most religions practised at present are grounded in deep history and tradition. Sculptures and writings have been passed on from generations and are integral to the sanctity of the religion. In addition, the use of digital technology can provide us with a mechanism to not only maintain the consistency of the teachings but also establish a real-time learning and understanding process for a variety of users. Islam is one of the largest religions in the world with almost 1/5th of the world's population being of Muslim faith (5). Since the birth of the religion took place in what is today known as Saudia Arabia, most rituals, teachings and practices related to Islam are done in the Arabic language. Although, the holy book of Islam, The Qur'an, is translated into many languages, it is always read in Arabic as a matter of principle and custom. A common myth regarding Muslims is that they all can speak Arabic - current estimates indicate that only 20% of Muslims speak Arabic as their first language (74). Hence, many Muslims in non-Arabic environments either rely on rote learning of Arabic verses within Islam without a focus on proper pronunciation and dialect, especially in younger children. This is particularly a dilemma if Arabic instructors are not available, as correct recitation of the Qur'an is imperative as a matter of principle (13). Traditionally, all forms of Islamic teaching in the Muslim world, particularly learning and reading of the Qur'an and praying, begins from young ages (as

little as 7 years old); therefore, it is imperative to enhance and facilitate the learning experience of children. Additionally, reading and understanding the Qur'an form an integral part of Muslims and many continue the learning process well into adulthood (75).

State of the art research indicates that there is the recent intersection of Islam and technology. Advancements in Arabic speech recognition have allowed checks and verification of *tajweed* (6), i.e. pronunciation of verses from the Qur'an (7, 8). Slowly in schools, colleges and universities based in the Muslim world, Islamic education is supplemented with novel forms of technology (9, 10). We can observe the proliferation of mobile apps in the developing world and the uptake of the same to teach languages (11) such as Arabic (12). Therefore, therein lies great potential in utilising mobile computing technology to promote Qur'anic education (13) particularly to the non-native speakers of Arabic. It is contemplated that mobile versions of the Qur'an can provide portability and accessibility in comparison to the physical copy of the Qur'an - "Mushaf" (14) as a result of which we see a number of apps being introduced in the market. The aim of this work was to set out to perform a review of existing Islamic religion-based commercial applications in the market to understand the gaps, trends, learning styles and user preferences. We contribute towards educational technology literature by providing design implications extracted from our review which are, firstly, relevant to apps aimed to teach Qur'an but some findings can be generalised and applied to other religious apps.

We focus on Apps available in iOS and Android platform in this chapter

due to children's high usage of phones and tablets.

3.2 Method

For our overview, we only focused on Apps available on the Android platform and IOS. Prior work indicates that apps listed to teach Qur'an are more than twice in number on Google Play Store as compared to the Apple iTunes store (14). We performed a thorough search on both Google Play and IOS Store to shortlist relevant apps. Keywords that we utilised were "Learning Qur'an", "Memorising Qur'an", "Reading Qur'an", "Understanding Qur'an" and their Arabic translations. Since more than half of the research team was bilingual (spoke both Arabic and English), we included any app that used English, Arabic or both in combination as the mode of interaction. Apps that we could not browse or download or which had no reviews were excluded from our analysis. In summary, we only focused on apps that were meant for teaching Qur'an as there are a number of apps that provided general Islamic education. Our codes were cross-checked against the app description or app summary provided on Google Play Store by the developer.

3.2.1 Characteristics Scheme

The coding scheme is comprised of a number of extracted variables. The codes are summarized under:

1. Medium of instruction, which was either Arabic or English.

2. The second code attempted to classify the main target group of the app into children, adults or the elderly.

3. The third code was the type of learning focus or main pedagogical technique employed by the apps which we coded into the following possibilities:

   (a) *tajweed*: The applied or conventional definition of *tajweed* is "Articulating every letter from its articulation point [makhraj] and giving the letter its rights and dues. The rights of a letter are its intrinsic and necessary characteristics [sifat] that always accompany it such as the imprisonment of running on of breath [jahr], imprisonment of the running of the sound [shidda], directing pressure of the letter to the roof of the mouth [isti'la'], or the absence thereof [istifal] and the nasal sound [ghunna]. The dues of a letter are its extrinsic and contingent characteristics arising from the intrinsic characteristics such as the heaviness [tafkhim] or lightness [tarqiq] that enters the body of the letter" (18). In summary, *tajweed* refers to the correct elocution, pronunciation of Qur'anic verses with a suitable speed of articulation. (19). Any app which focused on this learning style was placed into this category.

   (b) *tafseer*: *tafseer* is referred to as the science of the mode of ar-

ticulating the expressions of the Qur'an, its linguistic indications and singular and composite rules, its meanings interpreted as composite constructions and related matters (20). Apps dealing with the semantics were, hence, placed into this category.

(c) *hifiz*: An app that employed Hifiz as its mode of teaching concentrated on the memorisation of Qur'anic verses by the heart through repeated recitations. (21).

(d) *Noorani Qaida*: The *Noordani Qaida* is a teaching method for the Qur'an that explains the basic pronunciations of various phonemes. It is typically intended for children or for those who are beginning to learn the Qur'an.

(e) General: An app was placed into this category if it used two or more of the afore-mentioned pedagogical techniques in combination.

4. The modality of learning interaction made it the fourth code, where we checked if the app utilised audio, video or an interactive combination thereof (listen and repeat, listen and record).

5. As a fifth code, we also noted the Human-Computer Interaction elements comprised within the apps, pertaining to their specific features, functionalities and interaction styles.

6. The last three codes were quantitative in nature and were sourced from the Google Play Store. They were:

(a) number of downloads as a range

(b) total number of reviews

(c) average app rating.

Data was collected within one week in December 2016 and September 2017. All codes had a possibility to mark a category as not applicable or not available. Two coders independently coded 25% of the apps to resolve any ambiguities or disagreements in the coding scheme.

3.3 Results

In this section, we show our results and findings in two subsections where the first sub-section provides our findings in Google Play and the second sub-section provides our findings in the Apple store.

3.3.1 Google Play

Initially, our search gave us 256 apps upon which we applied exclusion criteria mentioned earlier giving us a total of 37 Learning Qur'an apps which were shortlisted for further analysis (see Table 3.1).

As expected, most of the apps were targeted specifically towards Arabic speakers (16). There were only 7 apps are meant primarily for non-native Arabic speakers. Similarly, there were only 6 apps designed for younger users such as children. With regards to the learning focus of our selection of apps, the popular type was *hifz* or memorisation with almost 1/3rd in

Table 3.1: List of apps short listed for further analysis from Google Play

App Name	App Name	App Name
Rattil	Im learning Qur'an	Ayat-Al Qur'an
Learn Qur'an	Qaida *Noorania* with Sound	Bayan Qur'an
Listen and read Qur'an	Memorise Qur'an	Mushaf *tajweed* - Holy Qur'an
Learn Qur'an Basics	Qur'an for Kids	Learn Qur'an within 48 Hours
Learn Qur'an for Kids	Learn the Qur'an for children	Learn Qur'an Recitation
Learn Qur'an Qaida	Teach your children Qur'an	Noorani Qaida Arabic Alphabets
Easy Qur'an Recitepr	Qur'an Tutor	*tajweed* Qur'an *tarteel* Rules
Simple Noorania Qaida	Qur'an Teacher	Qur'an Smartpen Word by Word
Learn Qur'an - Qaida Noorania	Memorise Qur'an	Al Qur'an
Qaidaa Noorania	Teaching Kids the Holy Qur'an 1	Al Qaida Al Nooraniya
Kids Qaida Series	Read, Learn, Memorise Qur'an	Eghra Free Learn Holy Qur'an
Noorani Qaida with Sounds	iQur'an	Qur'an Progress
Learn Qur'an		

number (see Figure 3.1). *tajweed* and *tasfeer*, in comparison, were adopted in fewer apps (around the 10% mark). More than 2/3rd of the apps employed listening to the audio approach with about half of them also providing an opportunity for the user to repeat the verses. Only 6 apps facilitated the recording of user audio. We noticed that the apps incorporated a wide

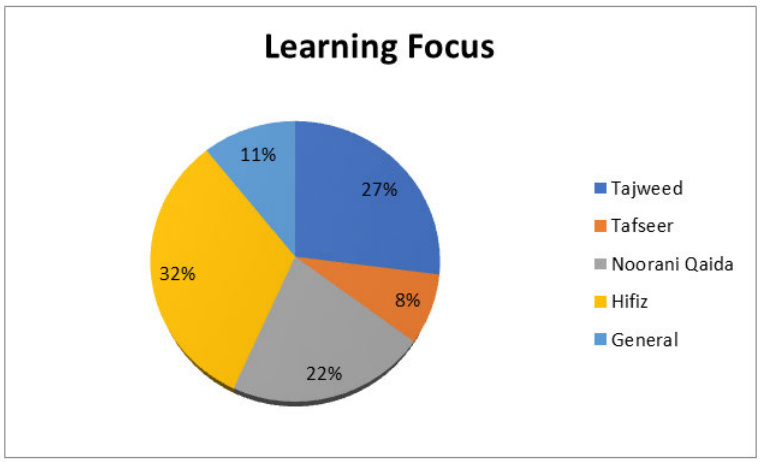

Figure 3.1: Qur'an Apps Learning Focus For Andriod

variety of features and human-computer interaction aspects. Most apps al-

lowed users to create profiles and consequently design tailored and guided lesson plans. A number of interaction strategies were designed to motivate the learners, for example through recording, sharing and comparing performance in online quizzes with others. In addition, most apps also provided offline interaction, allowing users to use the app without a data connection. Customisation was a key feature; most apps allow users to choose particular verses to learn through a number of recitation or memorisation settings (see Figure 3.2). Real-time detection of phonological errors and searching for words through voice was a novel feature, present in only 2 apps (such as in Qur'an Tutor - see Figure 3.2). In order to replicate student-scholar interaction as is in conventional learning of the Qur'an, some apps use video snippets of scholars reciting verses or phonemes which users could use to practice (such as in Learn Qur'an - *Qaaida Noorania* - see Figure 3.3).

We also recorded the range of total downloads and associated user reviews made on each app to gauge their popularity. Around 50% of the apps were downloaded between 100,000 and 1,000,000 times. On average, each app received a total of 12,065 reviews and a rating of 4.56. The most popular apps were Al Qur'an and Ayat Al Qur'an with more than 5,000,000 downloads, 100,000 user reviews and ratings of 4.5 and 4.7 respectively. We explored these two apps with some detail to analyse their features and design aspects. Al-Qur'an has a number of key attributes which stood out, such as it allows for easy navigation between the various chapters and sections of the Qur'an. Users were also able to go back to their active session conveniently. In addition, Al-Qur'an provides a two-way mechanism to explore

the Qur'an (scrolling or paging) (see Figure 3.4). Ayat Al Qur'an supports different techniques to learn the Qur'an (*tafseer*, *tajweed* and memorisation). It also allowes users to drill down and select specific verses for recitation (see Figure 3.4).

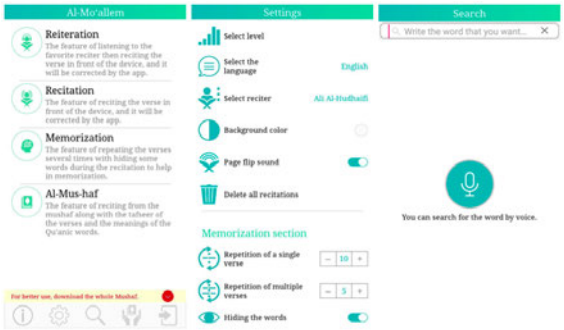

Figure 3.2: Screenshots from Qur'an Tutor When Downloaded on Author's Phone

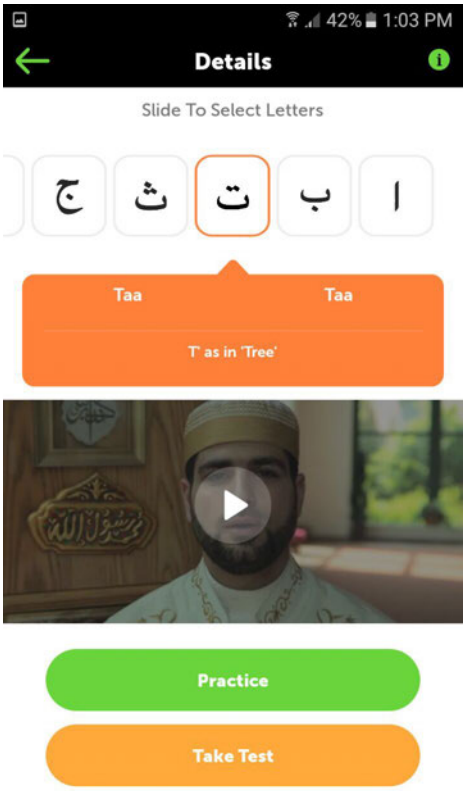

Figure 3.3: Screenshot from Learn Qur'an When Downloaded on Author's Phone

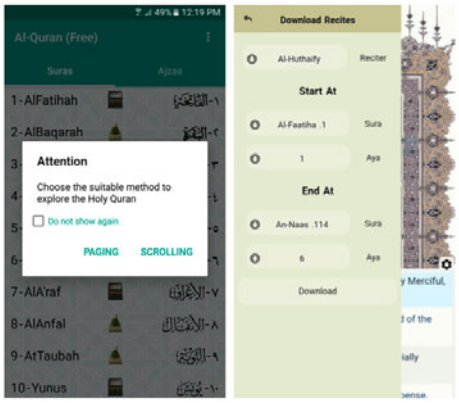

Figure 3.4: Screenshots from Al-Qur'an (Left) and Ayat Al Qur'an (Right) When Downloaded on Author's Phone

3.3.2 IOS Apple Store

On the other hand, our search gave us approximately 250 apps upon which we applied exclusion criteria mentioned earlier giving us a total of 85 Learning Qur'an apps such as "Let's Learn Qur'an with Zaky & Friends" which is specified for children, "Qur'an Touch *tajweed* with *tafsir* and Audio" which focuses on *tajweed, tafseer*, and memorization, "*Noorani Qaida* – Learn Qur'an with Lessons & Tajweed" which focuses on *Noorani Qaida*, *tajweed*, *tafseer*, and pronunciation, and "Qur'an Star" which is specified for children with a great feature of allowing kids to custom avatars.

About 20 apps targete Arabic speakers only; unlike Google Play, many apps found targeting non-native speakers, 54 of them, teach Qur'an with translation to a different language. Interestingly, 24 apps were designed for young users and children. As shown in Figure 3.5, and similar to the previous section, our learning focus investigates Hifis or memorization, *tajweed, tafseer, Noorani Qada'a*, and General. Our results show that apps specified for Hifiz or memorization were about 35% while 27% were identified for each category of *tajweed* and *tafseer* which indicates a greater focus on those in IOS Apple Store than Android. Similar to Android, around 24 apps employ listening to audio approach, while 18 apps intend to use an interactive approach for teaching.

As our findings in Android Apps, many of them incorporate a wide variety of features and human-computer interaction aspects. Many apps allow users to create profiles and consequently design tailored and guided

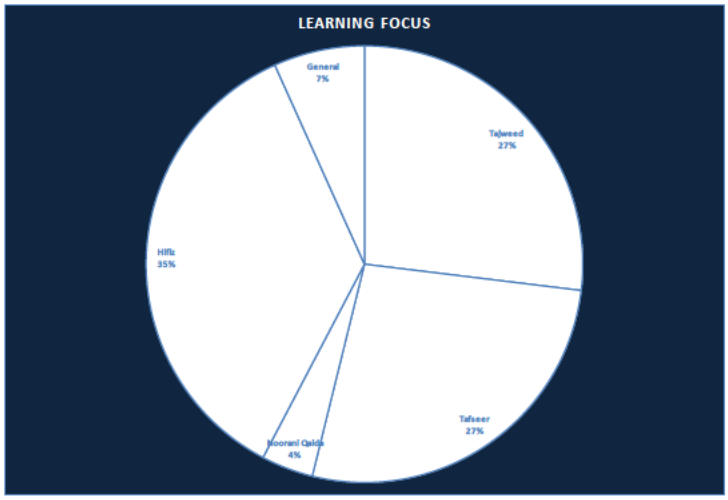

Figure 3.5: Qur'an Apps Learning Focus for IOS

lesson plans. A number of interaction strategies were designed to motivate the learners, for example through recording, sharing and comparing performance in online quizzes with others. In addition, most apps also provide offline interaction, allowing users to use the app without a data connection. Even more, some apps are enhanced to improve the battery consumption in smartphones. Customisation was a key feature, with most apps allowing users to choose particular verses to learn through a number of recitation or memorisation settings (see Figure 3.6).

Figure 3.6: Screenshots from Qur'an Tutor When Downloaded on Authors Phone

In order to replicate student-scholar interaction as is in conventional learning of the Qur'an, some apps use audio snippets of scholars reciting verses or phonemes which users could use to practice (such as Al *Qaida Al Nooraniya* - see Figure 3.7).

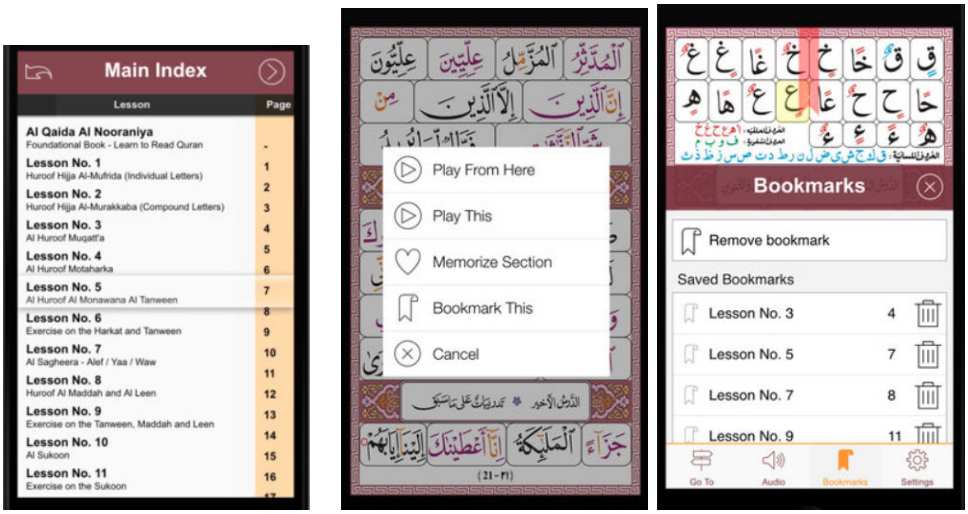

Figure 3.7: Screenshots from Qur'an Tutor When Downloaded on Authors Phone

It is noticed that given reviews from users in IOS Apple store were almost not provided in most apps. However, it is important to mention that apps use motivation such as Qur'an Star. In this app, "Earn 3 gold stars on every surah as you read, learn & memorize the final Juz' (section) of the Qur'an. It customizes multiple user profiles, tracks your statistics and unlocks in-app awards. It allows one to be proud of their accomplishments, share status updates on social media, challenge their friends to read and memorize the Qur'an along with you! Qur'an Star also has a recording feature built into the app that allows a user to test their memorization of each surah and send recordings to friends and family. Finally, the unique HuroofMeter counts the number of letters you read through each ayah. Can you read one million letters and earn one of Qur'an Stars toughest awards?" (See Figure 3.8).

Figure 3.8: Screenshots from Qur'an Tutor When Downloaded on Authors Phone

As per comparison between IOS and Androids, it is believed that the IOS Apple store has a better range of apps to teach the Qur'an. However, it mainly focuses on Arabic native speakers even though some translation was provided. It is highly believed that showing the Aya and its translation, *tafseer* and *tajweed* are not enough to learn Qur'an as non-native speakers may suffer from correct pronunciation and reading fluently. It is believed that the best way to teach non-native Arabic speakers is to have an interactive apps that users are able to listen and make corrections to their reading which indicates the concept of how to ensure that technology is able to check the accuracy and the correctness of one's learning.

3.4 Discussion: Design Implications for Qur'anic Apps

Results from the review of mobile apps intended to teach the Qur'an on the Android platform and Apple platform have revealed that although a number of relevant apps are present, there are still some open gaps in the field. The findings show that the primary target group for such apps are adult native Arabic speakers. In comparison, there are fewer apps for children and Muslims whose first language is not Arabic. It is commonly acknowledged that most digital solutions used to learn and read the Qur'an are tailored to Arabic speakers (31). In addition, it is also known that there is a dearth of Islamic apps specifically tailored for children (56). Future research in the area of Islamic and Qur'an apps should attempt to address this gap in the market.

The findings also show that real-time feedback on the correctness of pronunciation of Qur'anic verses is a rarely present feature, possibly due to challenges of voice recognition. Prior work shows that Arabic speech recognition is still a work in progress venture (76) with fluctuating recognition accuracy rates. A number of Arabic dialects also further complicates the task of researchers working on automated solutions. The overview also shows that most app developers realise the importance of providing a customised user experience when using mobile apps to learn the Qur'an. A wide user base who wish to learn the Qur'an requires mobile solutions to adapt to different learning styles, skill levels and convenience (19, 77). Self-

customisation and user-profiling of learning patterns and styles would be an essential design feature of any app which promotes educational aspects of a religion, such that users can learn, read and practice at their own pace.

The analysis also shows that about $1/3^{rd}$ of the short-listed apps provide the possibility of reading and learning the Qur'an through *tajweed*. This is not as large a number as would be expected given the importance of *tajweed* (78). *tajweed* relies on audio and visual feedback; hence, the apps which intend to incorporate *tajweed* may be susceptible to technical limitations. The review of the apps also illustrated that there was no evident mechanism to establish or verify the veracity and authenticity of the sacred content presented in the mobile apps. For example, information about accreditation or certification can be provided in the "about us" section or through an appropriate logo on the home page. It was not possible to establish if this was the case in the apps that were considered, at least such information was not immediately visible. Ideally, the developmental process of such apps should involve religious scholars as the importance of accreditation and standardisation of digital Qur'anic solutions has been highlighted (24). Involving religious experts and recognised Islamic scholars in the app creation process as a trust-building mechanism via a user-centred design process will also address the issues of acceptance and pessimistic attitudes (29, 30) towards the intermingling of Islam and technology. Other researchers (79) are using parsing or algorithmic techniques to establish the authenticity of digital versions of the Qur'an. This clearly highlights the aspect of certification as a challenging one.

Now, there is clear vision of the importance of those technologies and how they are capable of making a significant change in learning behaviors. Interactive system with motivation is a required addition to improve the collaborative learning and improve the teaching experience.

3.5 Summary

The penetration of smartphones is gradually increasing the proliferation of mobile apps for a variety of domain areas. In this thesis, an overview of mobile apps have been presented which are dedicated to teaching the Qur'an as a result of where certain implications for Qur'anic app design were presented, which could also be considered for apps for other religions. It is believed that this category of apps is still in the embryonic stage as the combination of Islam and technology is a sensitive issue (14), particularly if unintentionally errors occur during interaction. Furthermore, uptake of mobile apps to read the Qur'an is still met with resistance by some users, as face-to-face learning or reading the physical copy of the Qur'an ("Mushaf") may be a preference (13, 80). Our review indicated that there is a shortage of apps focusing on non-native Arabic speakers on the one hand, and children on the other hand. The long-term research endeavours is to utilize mobile technology to promote the uptake and learning of Arabic, Islamic teachings and Qur'an in non-Arabic speaking users. As the first step in the user-centered design process, the aim is to involve Sheikhs (religious scholars) from the community and internationally as a means to ground

and validate our findings and design ideas. We also aim to complete the overview by considering apps from the iTunes store. Lastly, we wish to investigate interactive modalities of teaching the Qur'an such as through gaming and visualisation engines, in particular, to appeal to children and younger users.

Chapter 4

Research Methodology

4.1 Introduction and Research Aims

In this research, consideration was given to the user-centred design and which combineed both quantitative and qualitative methods collaboratively to collect data from teachers and scholars in the approach. The data is collected in order to design the model of the approach; further, two rounds of testing is conducted. The details of the approach will be explained in the following part of this section.

The user-centred design employed in this research project contains two main phases: the user training phase and the user evaluation phases. The user training phase is used to feed the system and collect and extract the requirements to be implemented while the user evaluation phase employs the users experiences to evaluate the system and ensure its satisfaction with the requirements. Figure 4.1 shows an overview of the user-centred design. As evident in this figure, the model begins with analysis, followed by the

design, followed by the evaluation and ends with the implementation. The grey arrows indicate that more than one round takes place to evaluate and finalise the system.

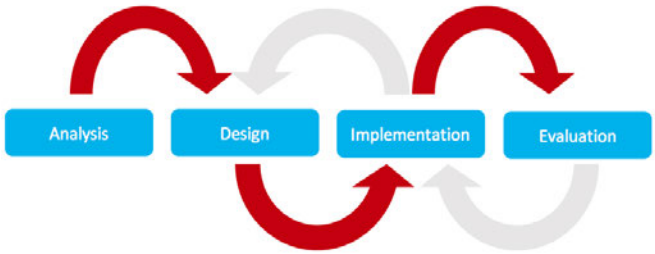

Figure 4.1: User Centred Design

The four main components in Figure 4.1, namely, Analysis, Design, Evaluation, and Implementation are as follows:

- Analysis: In this phase, data was collected from religious scholars and school teachers, then analyse them to understand what needs to be involved and what the difficulties and challenges in real classrooms are that need to be considered in the design.

- Design: After data analysis from the first component, the system was designed prototype was starting to be made.

- Implementation: Once the design is completed, the system was implemented and made ready for testing/evaluating.

- Evaluating: In this component, the system in round 1 was evaluated for testing to collect feedback from religious scholars and school teachers. Then, the system was optimized, before starting round 2

of testing and allowing teachers to examine the system on children in the classroom.

This research aims to provide a system that is capable in improving the teaching experience of Qur'anic education for non-native Arabic children. The right people who face real challenges and difficulties are school teachers in public schools or religious scholars who teach Qur'an classes in the Masjid (The Mosque). Focus is placed on them to build the system and ensure that the built system serves their needs and becomes of greater assistance for them to help them overcome their identified learning difficulties.

4.2 Appropriateness of the Research Design

The research for the dissertation is considered a mixed-method research as it combines both quantitative and qualitative approaches to its design. The qualitative method is used twice, once for data collection to design the system and the second time for the testing phase, round 1, where some feedback is collected to improve both scholars' and teachers' satisfaction. The quantitative method is used in the testing phase, round 2, where teachers are requested to take the system and examine it on children who are the target group.

4.3 Settings and Participants

In this thesis, there are three types of participants, namely, school teachers, religious scholars, and children. These groups of people are considered in three different rounds as follows:

- Data collection on design implication: such that an open interview will be conducted with school teachers and religious scholars to collect data about the design phase.
- After the system is designed, an open interview will be conducted with school teachers and religious scholars to receive their feedback and recommendations about the system which has been designed, during the first round of testing.
- The system will be enhanced based on the previous round of testing. Following this, the system will be given to teachers to examine it on children and provide the researcher with quantitative survey results about the system.
- Since the participants are children at an early age, it is quite hard to test the system on children as it is not an easy task to understand whether the system is helpful or harmful for them. Thus, it was decided that teachers acted as proxies to advise whether the system was actually improving their teaching experiences.

4.4 Pilot Study and Procedure

The entire procedure is presented in Figure 4.2. The procedure for this data collection is divided into four phases, namely, the initial study phase, the design phase, the testing phase, and the enhancement phase. In this section, each phase is described in more detail.

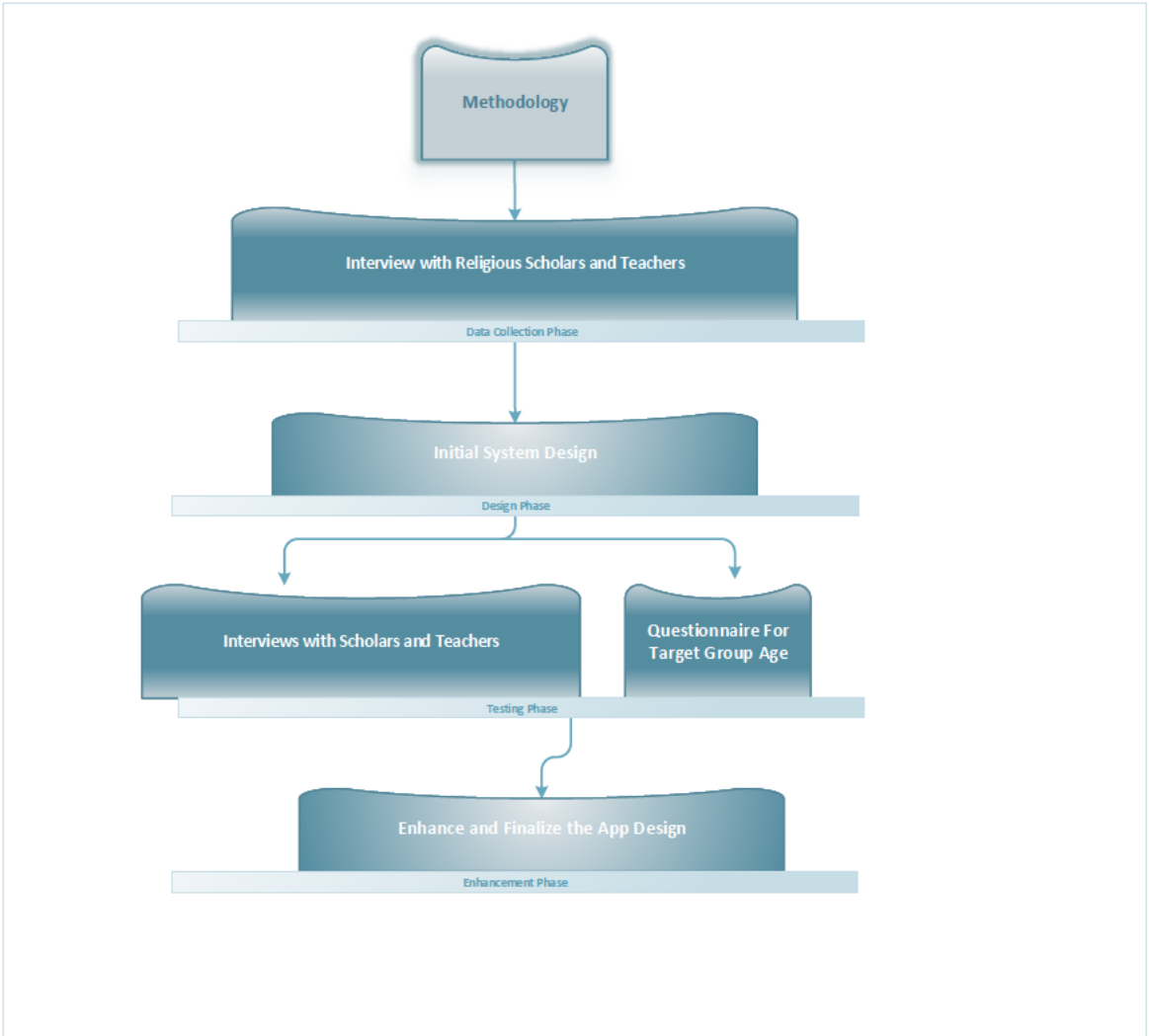

Figure 4.2: Methodology Overview

The aforementioned four phases are:

1. In the initial study phase, a qualitative study takes a place, such that, the open interview has been conducted with both types of instructors, namely school teachers and religious scholars which focus on challenges, difficulties, and system implications.

2. Using the data collected from the interviews, the initial design of the system begins and is ready for the next phase.

3. In the testing phase, the system is designed in the previous step for testing. The system is distributed among all groups, namely school teachers and religious scholars.

4. Finally, the aforementioned collected data was used from the testing phase in order to enhance and finalise the system design before the second round of testing is conducted, which allows teachers to try the system in an actual classroom on children, targeting the group of children between 4-7 years old.

4.5 Instrumentation

In the initial study phase, the qualitative study consists of questions made for an open interview with scholars to investigate the real challenges they may face especially with the target group of children, which may be sophisticated and difficult. For instance, the open interviews with teachers

focus on the main challenges which the teacher may face when teaching a different language. The ultimate goal behind the open interviews with all groups described before is to provide key concepts to design the system and specify how the interaction method might take place, as well as what should be avoided with children and what could be used to encourage them further in their learning.

Once the system is designed, two rounds of testing is conducted. The first round is to get an opinion from scholars and teachers, while the second round is for all teachers to test and examine the actual system on children and fill a survey of observations about each child.

Data collection through a qualitative study and open interview with religious scholars and school teachers are fully described in the following section. In the test phase, as mentioned above, two rounds of testing will take place. The first round has been completed based on the qualitative method and an open interview with both groups of instructors, focusing on receiving feedback about the system and a set of recommendations to improve it.

On the second round of testing, a questionnaire is given to teachers to examine the system on children and provide answers on a rating scale of 16 questions. These questions focus on children's performance before and after using the system, and some other features examining the system which will be detailed in Chapter 7. The next chapter describes and shows the data collected from both types of instructors in order to build up the system.

Chapter 5

Data Collection

5.1 Introduction

Since the birth of the religion took place in Saudi Arabia of today, most rituals, teachings and practices related to Islam are done in the Arabic language. Although the holy book of Islam, the Qur'an, is translated into many languages, it is always read in Arabic as a matter of principle and custom. Hence, many Muslims in non-Arabic environments rely on remote learning of Arabic verses within the Qur'an without a focus on proper pronunciation and dialect, especially in younger children.

This becomes a dilemma if Arabic instructors are not available, as correct recitation of the Qur'an is imperative as a matter of principle (13). Traditionally, all forms of Islamic teaching in the Muslim world, particularly learning and reading of the Qur'an and praying, begin from young ages (as little as 7 years old); therefore, it is imperative to enhance and facilitate the learning experience of children. Additionally, reading and understand-

ing the Qur'an forms an integral part of a Muslim's belief and as such many continue the learning process well into adulthood (75). Currently, most Islamic education takes places in either dedicated religious schools (Madrassahs or mosques, headed by sheikhs or religious scholars as extra-curricular after school or weekend classes), in Islamic specialized private school, or at home by either parents or co-located religious scholars (81). Reading (Tajweed), understanding (Tafsir) and memorizing/learning (Hifiz) the Qur'an are normally considered as different and independent modes of teaching the Qur'an.

As mentioned prior, the Qur'an is read in Arabic but is governed by additional grammar and pronunciation rules as compared to everyday and colloquial Arabic (82). Therefore, we believe that each mode of teaching is in itself a challenging task and in order to scope this research, we would like to focus on the usage of interactive technology to facilitate the reading of the Qur'an. As shown in the previous chapter, we believe that although numerous forms of technology have been used for reading, learning and memorising the Qur'an, their development has been mostly driven by engineers, natural language processing researchers and computer scientists. Therefore, the involvement of the end-user in the form of religious scholars and teachers is not clear, nor is their overall acceptance and perception of the use of such technology. Therefore, in this study, we report on a qualitative study set out to elicit the requirements and the needs of interactive technology to facilitate the reading of the Qur'an from religious scholars as well as from primary school teachers. In addition, we wanted to under-

stand the current teaching practices and the potential role of technology in assisting both teachers and students with reading the Qur'an.

A series of qualitative face-to-face individual open-ended discussions were conducted with a set of primary school teachers (N=5, 5 F) and religious scholars (N=4, 4 M), where every interview took approximately (30-45 Minutes), all of whom were extensively involved in imparting Islamic education (Qur'anic teaching in particular). All discussions were conducted in suburban areas of a metropolitan city in Australia. The required ethics approval was attained from our host educational institution (Ethics Approval Reference: H12880). Recruitment of the primary school teachers was enabled by liaising with the school principal in the first instance. Information sheets and consent forms were emailed to the school management who then advised us of the availability of the teaching staff. We then attended the school premises to meet the teachers. The religious scholars were approached by contacting the management of religious centres and mosques in the suburbs from our local area. As in the case of the school teachers, consent forms and information sheets were emailed to the management of the religious centres who then put us in touch with the religious scholars. Due to the sensitivity of the topic, all discussions were conducted anonymously and individually so as to avoid bias, and/or reluctance to openly speak in front of others.

The discussions were centred around the following main aspects of Qur'anic education:

1. Understanding the current teaching structures, styles, methods and practices across both primary school teachers and religious scholars

2. Understanding challenges faced by both instructors and the students while teaching and reading the Qur'an respectively within their current setup

3. Contemplating the contribution of technology within Qur'anic education and discussing any fears, reluctance or acceptance issues on behalf of the instructors

4. Visualizing potential features and functions of interactive technology for Qur'anic education

In the qualitative study 1 in Appendix A, the aim is to outline the challenges and difficulties needed to be overcome within the design phase.

5.2 Analysis

In general, both teachers and scholars were positive and welcoming in engaging with the research project and offered to provide long-term assistance in our endeavours. It was also observed that by large the perception and potential role of technology within Qur'anic Education was positive. In this section, some of the main themes that emerged from the discussions with both scholars and teachers are presented. Quotes are also presented from the group of participants, where T_ID refers to a primary school teacher and S_ID refers to a religious scholar.

The two main categories were all quotes that have been analysed and are the current class structure and challenges faced therein, and the role of technology, possible technological interventions and implications.

5.2.1 Current Class Structure and challenges Faced Therein

All of the primary school teachers in our sample reported on following a similar class structure while teaching how to read the Qur'an to children. Using a computer or slideshow, and showing a verse from the Qur'an was first displayed to children. The teacher would then recite it loudly, explaining each letter and its pronunciation after which the students would repeat the verse. The extent and nature of technology currently employed by the teachers varied. Some suggested that they would use websites (such as Qur'an Explorer [T1], Zaky [T5]) or YouTube videos in class to supplement the reading process. In line with the research aim, the focus of the primary school teachers was not on memorization but reading the Qur'an:

> *" We don't like to use memorizing. We prefer if the student can pronounce letters correctly...The most important thing for us is reading. The kid can depend on him/her-self, open the Qur'an and read by him/her-self." [T3]*

Two teachers clearly mentioned that they did not trust all of the existing technological solutions and they required a clear indication that the software emerged from a trusted source, as evidenced by the quotes below:

" We cannot trust all the mobile technologies; you need a trusted Islamic resource." [T5]

"We need to trust the resource. Any kid can go and use any app without supervision. It has to be used under supervision." [T5]

"...not being able to distinguish the right Islamic knowledge from edited, fabricated knowledge. It could become misleading." [T2]

Most teachers preferred and followed a group-based learning activity but emphasized on allowing some time for students to articulate the verses individually so that their pronunciation could be established (particularly students who were beginners). This was interpreted on the basis of the following comment:

"As a group, they motivate each other. Sometimes, I prefer to listen to every student separately, to correct everybody's mistakes." [T4]

It was interesting to note that the lesson structure adopted by the religious scholars was not too distinct from the primary school teachers, despite some scholars reporting that they only met the children once a week (typically on weekends or in after school sessions). Most instructions were face-to-face with some use of basic technology such as a projector and involved repeated recitation led by the instructor supplemented with YouTube

videos of renowned scholars for example [S4]. The importance of face-to-face interaction in addition to any implemented technology whilst reading and learning the Qur'an was highlighted by all the scholars, as also derived from the following quote:

> *"It's (Technology is) so important but not enough. It requires checks especially in letters pronunciation which need to be taken verbally (face-to-face). I need to see how the lips are moving..." [S4]*

Interestingly, one scholar mentioned how he was utilizing Whatsapp as a means of correcting the recitation of the students:

> *"I ask my students to send a recording through WhatsApp and I correct their recordings." [S2]*

In addition (and similar to what was mentioned by the school teachers), the scholars also stated that their primary focus was on correct reading and pronunciation and this formed an integral component of the lesson:

> *"As a teacher, I have to pronounce those letters correctly in the front of the student and he repeats after me." [S2]*

> *"I don't focus on memorizing. I may meet the student once or twice a week. I'm focusing on enabling the child to read the Qur'an properly and to get a simplified understanding of what he is reading..." [S2]*

Similar to the primary school teachers, the scholars preferred working with groups of students as a means of engaging and motivating the students [S1,S2,S4] coupled with phases where at one time only one student was reciting aloud:

> *"I can't make them read at the same time. For example, I'm reading and they are repeating at the same time... The voices are overlapping and one student may hide the others' mistakes." [S4]*

It was noted that most teachers commented on two primary challenges faced by the students when reading the Qur'an in their current setup: 1) pronunciation and 2) boredom. In particular, the teachers commented how pronunciation was a predicament for children with no background in Arabic:

> *"The non-Arabic speakers find it difficult to pronounce certain sounds." [T3]*

The teachers utilized a number of techniques to overcome the boredom faced by children in their class when reading the Qur'an:

> *"...when you feel they are bored, you need to change the topic or you can make activities in order to regain their attention..." [T3]*

> *"...sometimes we display Islamic cartoons..." [T4]*

> *"I spend less than an hour with the kids. The whole time is not reading and repeating. We give them different activities..." [T5]*

The scholars reported establishing correct pronunciation as a key challenge, in particular with children who had a non-Arabic background [S1,S3], as indicated in the following quote:

> *"The problems that non-Arabic speakers face when they are learning Qur'an are related to pronunciations, reading the letters when they are connected together, tajweed rules. The child does not know the meaning of what he is reading. They are memorizing everything as it is without understanding." [S3]*

Since the scholars were running the Qur'an classes as special extra-curricular sessions, they had more flexibility in maintaining the engagement of the children. All scholars mentioned that the key was to retain the attention of the children and motivate them in the process of learning the Qur'an. This was illustrated through quotes from one scholar in particular [S2]:

> *"...(We need) to tell the child stories from the Qur'an and try to connect these stories to our life. The child has to feel that the Qur'an is not a normal book; it's a way of life. The teacher has to be creative..."*

"I use the interactivity outside the classroom. I take the students to a park..."

5.2.2 Role of Technology, Possible Technological Interventions and Implications

Since the focus of this study was to explore the role and usage of technology in reading the Qur'an, we had a thorough discussion on the aspect of eventual advanced technological interventions in the classroom as visualized by both teachers and scholars. Possible features to be incorporated were discussed as were potential implications and issues that may arise due to the use of technology.

The use of speech-based interaction through technology was discussed, given the primary task in learning the Qur'an is reading it. At this stage, we did not discuss the challenges of Arabic speech recognition of children recitations, since we felt this was out of the scope of the current study. In fact, one primary school teacher suggested that face-to-face interaction was imperative in evaluating the recitation of the students:

"...you have to see how the child is pronouncing (the movement of mouth, tongue, lips,... etc.) and the child has to see you too..." [T5]

Nevertheless, the primary school teachers were supportive of one-way interaction (automated verbal recitation to the students without machine-

enabled recognition of the recitation of students). In addition, the teachers mentioned the use of a voice recording functionality:

> *"...where a child can record their voice and repeat it with the correct pronunciation is something that is easy to do and sufficient in helping children to recognise their wrongs..." [T1]*

The primary school teachers emphasise the need of having technology that is colourful, animated [T3] and ultimately keeps the children engaged. The use of competition [T3], games [T1] and rhythm-based exercises [T1] was highlighted. Recognizing the progress of the student and providing encouragement and praise were the key findings. The use of a marking the scheme was also mentioned [T1]. Further examples are exemplified by the following quotes:

> *"...giving the child a star when he/she finishes a certain task or writing his/her name on a leaderboard" [T4]*

> *"...gaining points, promotions, certificates on completion of level for recognition. This makes the child feel that they are monitored and their participation has been assessed..." [T2]*

> *"...If they have a reward system... where they can level up is a great way to keep children interested..." [T1]*

The scholars stated to be not fully convinced with the accuracy of Arabic speech recognition for the Qur'an [S1] which, along with avoiding distraction

in students [S3], was one of two reasons of having supervision as a prerequisite before technology was incorporated. The scholars provided helpful suggestions on different features that could be included in prospective technologies meant to assist in reading the Qur'an. Reward mechanisms were seemingly sought after and their inclusion was requested by the scholars; for example:

> *"...It's important to use the carrot and stick reward and punishment (approach)" [S3]*

As a means to correct any unintentional errors in the scriptures or interaction, the scholars suggested that they should have a connection with the technology developers so that feedback could be provided [S2]. Animated interaction was alluded to (such as characters [S3]) but the scholars did not explicitly mention the requirement of gamification.

In addition to discussing the benefits of using technology in reading the Qur'an, most of the participants were observant to point out certain key challenges and issues that were integral to be addressed prior to formal use of any computing system. The importance of a human teacher was stated in particular by the primary school teachers to identify errors in pronunciation:

> *"...repeating how you think it sounds multiple times only assists in learning the word in an incorrect manner." [T1]*

Over-reliance on technology [T2] and lack of training to the instructors [T1] were also identified as possible obstacles. The primary school teachers also stressed the importance of having the children use any system or

technology under supervision [T4] as they felt that the children may get distracted [T1]. The role of parents and at home-learning through any system or technological solution was also mentioned:

> *"The best form of support is that of the parents... (As they can) monitor technology usage..." [T1]*

The scholars also pointed out that the parents had to play a supervisory role in the success of any technology. The scholars were supportive and appreciative of a feedback mechanism in the system which could relay the performance of the child to their parents on a regular basis [S1,S2,S3] - not just critical feedback but also positive developments. This was deemed as important as the scholars were only interacting with the children for a few hours every week. The scholars also pointed out that improved learning of the child using specific technology depended on a joint effort from the parents and the instructor, as judged from the following quote:

> *"We have to take into account that the parents are non-Arab. It may be hard for them to evaluate the content of the app (technology). They can tell you it looks nice and so on. For evaluating the app (technology), you need someone who has a background in Arabic and Islamic sciences or the teacher himself." [S2]*

Akin to the primary school teachers, as we have mentioned prior, the scholars considered face-to-face interaction as integral to the process of learning the Qur'an and warned of an over-reliance on technology:

> *"The students may have some things that need to be clarified by the teacher. In this case, the technology alone will not be enough." [S1]*

5.3 Discussion

The research and discussions with primary school teachers and religious scholars have revealed interesting findings with respect to Qur'anic education for children. In general, and perhaps contrary to expectation and prior work (83), there was a generally positive outlook towards the use of technology in Qur'anic education. Both school teachers and scholars were utilizing varying levels of technology in their current setup and were eager to incorporate advanced forms of technology under certain conditions. Two key constraints and considerations mentioned were persisting with face-to-face contact and establishing close supervision on the children while they interact with the technology. It is well understood that maintaining facial contact between the instructor and student is a key component of linguistic education (84) as this also came to the fore in the discussions.

Retaining student attention was also considered to be a challenge by both groups of instructors, particularly for children who did not speak Arabic as their first language. In this case, students were essentially learning the Qur'an and its grammatical rules without an understanding of the Arabic language. Any subsequent deployment of technology would also need to consider the particular requirement of being able to support both individu-

als and the collaborative study of the Qur'an: the former to ensure correct recitation and the latter to facilitate motivation.

Despite the linguistic nature of the act of reading the Qur'an, both groups of instructors appeared reluctant to rely completely on the automated speech recognition for future technology. Rather, they were more supportive of one way audio interaction, such as the child sharing his/her vocal recitations with the respective instructor. In recent times, we have already witnessed the popularity of Qur'an lessons over Skype and other video conference software (85). In this study, animated interactions and characters were also considered worthy of inclusion.

A key aspect mentioned by both groups of instructors was the act of rewarding, praising and encouraging children on their effort and performance, which is an established strategy in primary school teaching. Both teachers and scholars were highly cognizant of the importance of establishing the (religious) authenticity of any technological application, which remains an ongoing area of investigation in software applications for Islamic teaching (86). The scholars, in fact, also requested for a direct link with the developers so that errors in the application could be addressed. Religious scholars in Islam are held in esteem and function as a kind of regulatory institution with the ability to action such suggestions and amendments. Lastly, both school teachers and scholars stressed the importance of the parents playing an active role in the Qur'an reading activity of the children alongside the primary instructor. Their role extended to the supervision of learning both with and without technology and monitoring the progress of their children.

Based on the centric user design, scholars and teachers were interviewed to design the system based on their vision, actual classroom challenges, and child difficulties they face. Thus, the list below has been included in the system either in the virtual classroom design or in the self-practice design.

In summary, the significant design implications for Qur'anic education that have emerged from the discussions with primary school teachers and religious scholars have been listed. These design guidelines would pertain to the development of new technology that is meant to be used for reading the Qur'an in a classroom:

1. Supplement proposed technology with human instruction and automatic speech recognition of Arabic should be cautiously incorporated
2. A reward mechanism is vital to not only motivate children but also to allow them to monitor their progress.
3. The proposed technology should demand and allow parents to play a key role in the Qur'anic education of their children
4. The credibility and authenticity of the proposed technology for Qur'anic education should be transparent and easily attainable
5. The proposed technology should cater for both individual and group-based Qur'anic education
6. The proposed technology should allow the instructors to have a direct link with the developers so that any errors in the scripture or interaction can be rectified.

Chapter 6

Design and Implementation

6.1 Prototype Basis and Knowledge

Based on the findings from the feedback and suggestions received from a group of instructors, namely teachers and scholars, the plan is to leverage a reinforcement learning model to build an intelligent mechanism for improving the effectiveness of the learning system. This is due to the fact that there is no prior knowledge about the target group of children; their background, strengths, and difficulties.

The designed simulator builds knowledge about children's capabilities before it starts interacting with them and actually provides maps of practice which satisfy the needs of each child.

The system deals with the "Nooraniah Qaidah" and its lessons, such that each lesson is in one map, and each map consists of "OutletSets" which consist of about 28 "Outlets" all up.

For instance, children and their teacher are to log in to the system.

Children have two main options to work on; one is self-practice for 'how' exercises, while the other is a virtual classroom, which contains the entire system features such as reinforcement learning and a speech recognition system. In the second option, three maps in total appear in front of the child to examine their performance and build knowledge about the child's area of strengths and weaknesses. Every map consists of 28 outlets from "Nooraniah Qaidah" supported by a speech recognition system. Two failures in the same outlet will activate the avatar movement pronunciation, while five failures will notify the teacher and request for immediate help by them. After three maps are completed, the proposed reinforcement learning system decides about the next maps.

Noorani Qaida is simply defined as a series of books for learning the Qur'an in Arabic. The results of the previous study confirm that Noorani Qaida has a positive impact and attitude on non-native Arabic children (73). According to the same study, the Arabic language is a very complicated language. Thus, even though the aim is to try to get a single character/ phoneme to first rather than reciting a full verse, it is believe that this is the best to do with non-native Arabic children as confirmed in (73). However, for children in this target group, repeating without understanding is significantly influenced by the word length (87), which gives this research another reason to continue improving via Noornai Qaida instead of attempting the recitation of a full verse. However, it would be interesting to find Google API WER in comparison between recitations of full verses compared to the Noorani Qaidah program.

6.2 Implementation Setup, Steps, and Tools

In the back-end design, focus was placed on the administrator page which allowed for adding features like a new character, outlet, certain map etc., and assigning students to certain classes or teachers as well as managing new accounts. PhP Laravel was used for this part. In the front-end design, there are three main aspects in the implementation, which are as follows; HTML, CSS, and Java Script This part includes:

1. A login page, avatar selection and avatar movement toward the classroom
2. A self-practice environment
3. a virtual classroom environment

6.3 System Overview

The system overview in Figure 6.1 shows the bigger picture of the entire proposed system. Details are as follows:

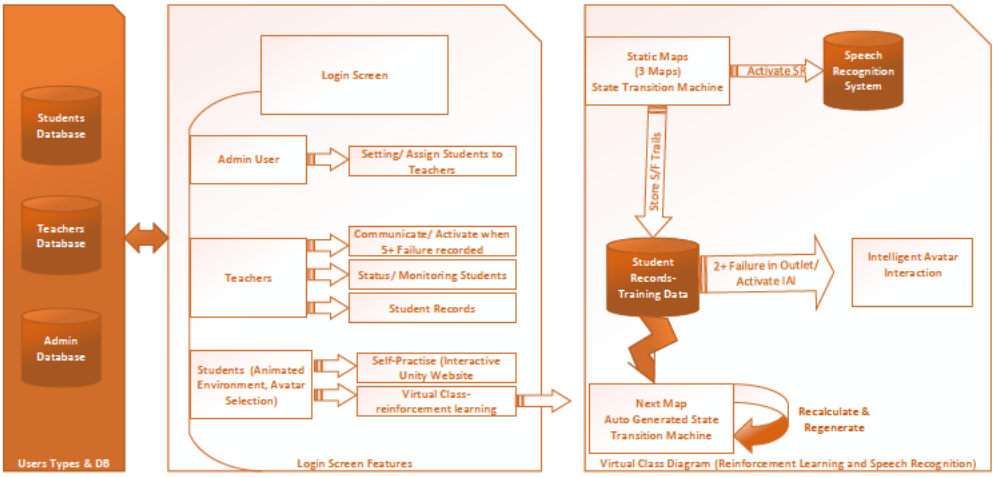

Figure 6.1: System Overview

- User Types & DB: This module contains three types of users: administrators, students and teachers.

- Login Screen Features: Each type of the users may perform a set of tasks as follows:

    1. (Admin) is to set up the environment required and assign students to teachers.

    2. (Teacher) is to directly communicate with the child whenever some help is needed or violate n number of pronunciation failures occur in the same Outlet. (Teacher) is to check students' status and monitor students accordingly. (Teacher) is to find the students' record also.

    3. (Student) is to select an avatar for the virtual environment. The child can either choose a self-practice system or choose a virtual

classroom where teachers are involved.

- Virtual Class/Reinforcement Learning Diagram: There are three static maps based on a state transition machine built via reinforcement learning along with a speech recognition system. These maps are the first three lessons out of the "Nooraniah Qaidah" program. Since there is no training data, the state transition machine will build a training database for each student based on the probability distributed from the state transition machines. After the three maps are finished, the next maps (up to 15 maps) is dynamically generated based on the reinforcement learning and it's dictionary. The student will hear the phrase or outlet then try to pronounce it. Two failures in a map will activate the intelligent avatar movement. This is called a try and error mechanism, where the reward and punishment of the system are either coins or failure.

  It is important to mention that during the maps trail, if the student failed to make a correct attempt twice, then the Intelligent Avatar Interaction Model is requested to show the student where and how the outlet can be pronounced. However, if the student reached five failed attempts, then the teacher will be requested to help the student verbally.

6.4 Web Simulator

The web simulator, signing in page in Figure 6.2, consists of three types of users, namely the Administrator account, the Teacher account, and the Student account. Details for each of these accounts are in the following subsections.

Figure 6.2: An overview of Accounts

6.4.1 Administrator Account

The Administrator account holder is responsible to assign privileges to others. Also, it can add and remove avatars, outlets, voices, and special maps. The Administrator account holder can assign other administrators to the system as shown in Figure 6.3.

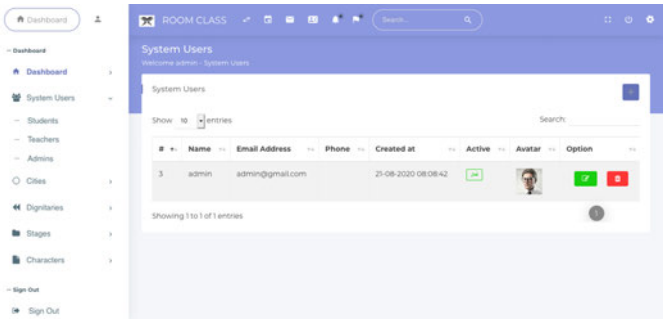

Figure 6.3: Assign Admins to The System

It also can assign teachers to classes and become the course planner, as shown in Figure 6.4.

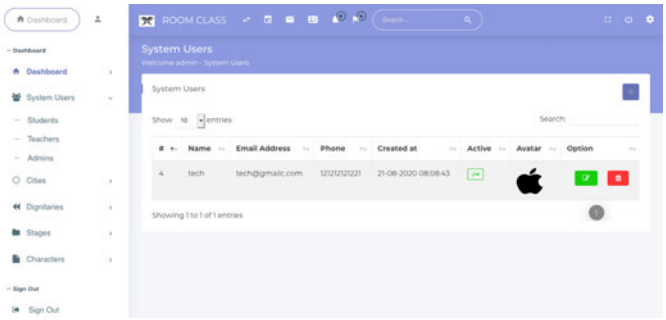

Figure 6.4: Teacher Administrator

Finally, the Administrator account holder can assign students to a certain teacher or classes, as shown in Figure 6.5.

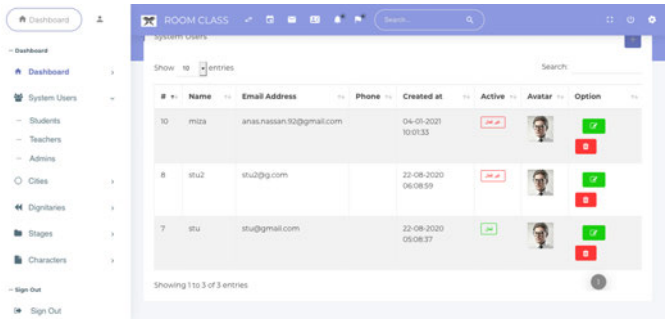

Figure 6.5: Student's Administrators

6.4.2 Teacher Accounts

The teacher account for teachers is very important for the interactivity as it is powered by three main functions, namely communication with students, student status, and student information. All the data about children and their progress as well as the state of record during the system activity is collected here. Whenever the student wishes to have a discussion with the teacher, the student can request to communicate with the teacher and this will pop up a message in the teacher's account, as shown in Figure 6.6.

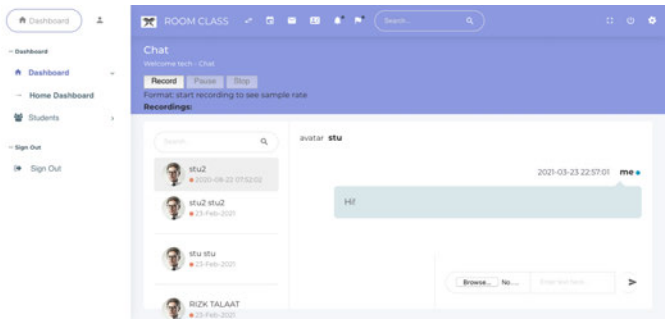

Figure 6.6: Communicate With a Student

Moreover, whenever the child reaches five failures within the same char-

acter or outlet, the teacher will be immediately notified of this. Then, the teacher can provide help and let it pass, as shown in Figure 6.7

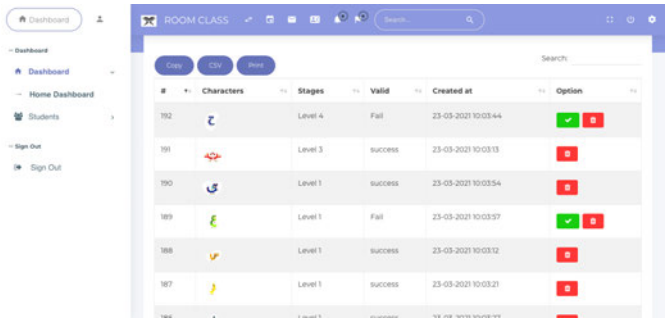

Figure 6.7: Student Status

As shown in Figure 6.8, the teacher can watch the entire class, who is online, what character they are doing, and how they are progressing.

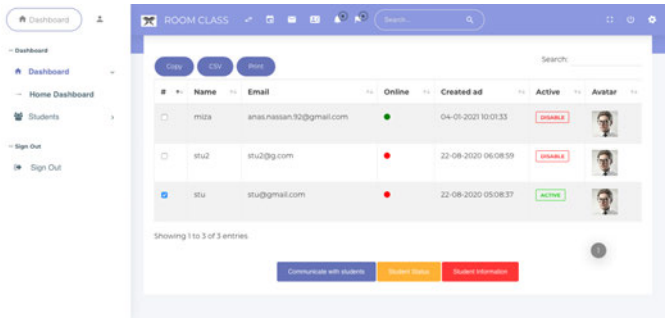

Figure 6.8: Main Page

6.4.3 Student Accounts

This account is built at the core of the proposed system. Once a child logs on to the system, the student will be redirected to the avatar selection page (Figure 6.9) where the child can choose the avatar that suits them the most. After the avatar is selected, the avatar starts the animation to walk

into the classroom (Figure 6.10). Once the avatar sits down, the computer screen will be running and zoomed in with two main icons (Figure 6.11). The following subsections will contain a descriptive details on what features have been implemented for the Student account.

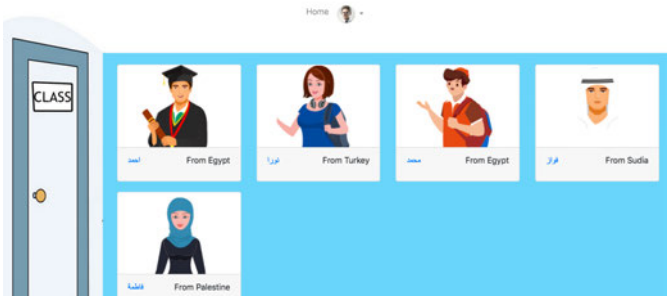

Figure 6.9: Avatar Selection Page

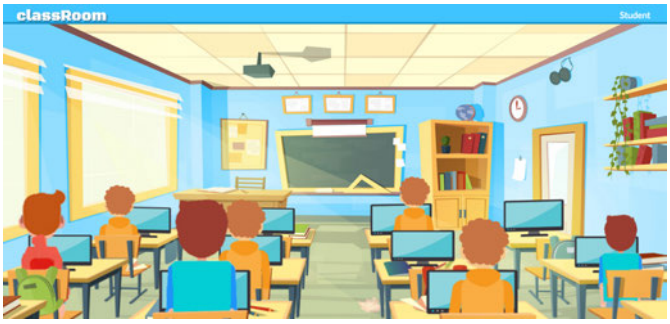

Figure 6.10: Avatar Walking to the Class

Figure 6.11: Computer Zoomed in

6.5 Qur'anic and Islamic System for Non-Native Arabic Children

The zoom in computer screen consists of two main icons, namely self-practice and the virtual class, which will be explained in detail in the following subsections. The core of the system is built on this screen as children are the target group of participants. Moreover, this section focuses on both Islamic and Qur'anic education as they together will build solid knowledge in children in order to achieve the main goal of Qur'anic teaching, as well as improving the teaching experience for teachers.

6.5.1 Self-Practise

We have built this feature to ensure that students and parents at home have a comprehensive solution for their child in which they could try at home, considering both Islamic education and Qur'anic education. As shown in Figure 6.12, this platform consists of five main features along with a parent-

teacher exchange platform. This enables the teacher to leave assignments and feedback for children.

The first feature in this platform is the Verses of the Qur'an, where children or their parents can listen, read, and understand every single verse of the Qur'an. They can choose the reciter and listen to the verse multiple times in an interactive way. They can also choose any language for the explanation for the verse, which is referred to as *tafseer*.

The second feature is ablution which is referred to as Wuḍū. This is the practice of how to get ready for praying. It has been explained step by step using a graphic interchanged format to help the child do it correctly.

Figure 6.12: Self practise Fully Graphics Interchange Animated Platform

The third feature in this platform is the character outlet which helps children pronounce the Arabic alphabet. Further, it shows where the letter is coming from within their mouth.

The fourth feature in this platform is the prayer, which consists of multiple steps that have been explained using graphic interchange format made

by Unity 3D. It focuses on how to pray, showing it movement by movement.

The fifth feature in this platform is the Nooraniah Qaidah program, which is presented by a series of video lessons to explain what the Qaidah is referring to and what it focuses on.

6.5.2 Virtual Class

This section initially consists of three maps for all children to be in the same position to examine, evaluate, and build training data for the system about the particular child. Each map consists of a set of outlets brought from Noraniha Qaidah, for example, the first map in Figure 6.13. The concept behind those maps will be described in thereinforcement learning model, described in Section 6.5.2.2. The child has to start from the starting point in a sequence to reach the end. Every map contains the level number (which is the map number), the last outlet completed, coins collected, the scoring success, and the score failed (how many times failures occurred).

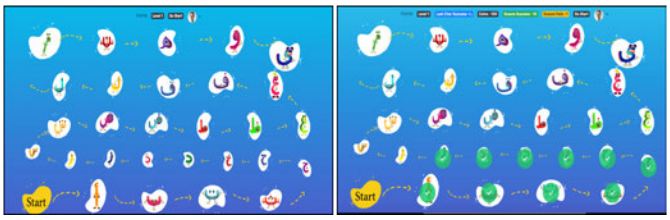

Figure 6.13: Reinforcement Learning Maps

The outcome of each pronunciation trial, which is less than 2, is either correct or wrong, as represented in Figure 6.14.

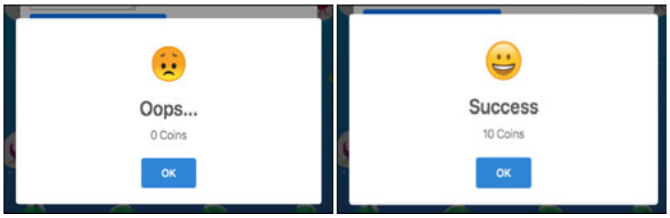

Figure 6.14: The outcome of Each Pronunciation

The intelligent interactive avatar movement, as shown in Figure 6.15, basically focuses on the avatar mouth to help the child to bring the outlet from the mouth correctly. This feature will be activated once the child failed to make a correct pronunciation after 2 trials, while the teacher will be notified for help after 5 mistakes.

The study (88) emphasises teaching English for very young children takes into consideration 5 variables: LISTEN, DO, REPEAT, UNDERSTAND, and REMEMBER. From this method, the concept of 2/5 mistakes was built. After two trials, the child should REPEAT if a mistake occurs, however, it was decided to make it a different kind of listening where the Intelligent Avatar Movement model has been activated. If the child continues to pronounce wrongfully, then the teacher will be notified and requested to help, so the child will always REMEMBER. Thus, after two failed trials of wrong pronunciation, the Intelligent Avatar Movement model will be activated, and after five wrong trails within the same outlet, the teacher will be requested to help and intervene in the child's learning.

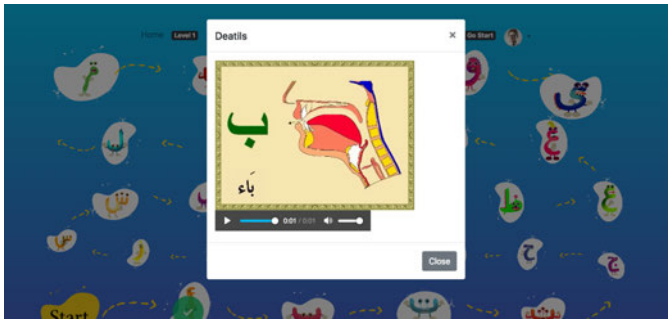

Figure 6.15: Avatar Mouth Movement

Each lesson in the Nooraniah Qaidah is represented on a map. Each map is represented as a state transition machine. Figure 6.16 shows the state transition machine corresponding to the first map in the Noraniha Qaidah. As it is clear in this figure, there are 28 states in this machine. The student starts from the first state and ends at the final state. At each state, there are only three transitions, including forward, backward and loop transitions. We provide more details about the formulation of punishment and reward equations for each transition in this state machine.

The first three maps are used to build some knowledge about children before the fourth map is dynamically generated based on the participant's strengths and weaknesses and the probability distribution, which will be explained in the next section. Every state machine has a starting point and terminal state or final state.

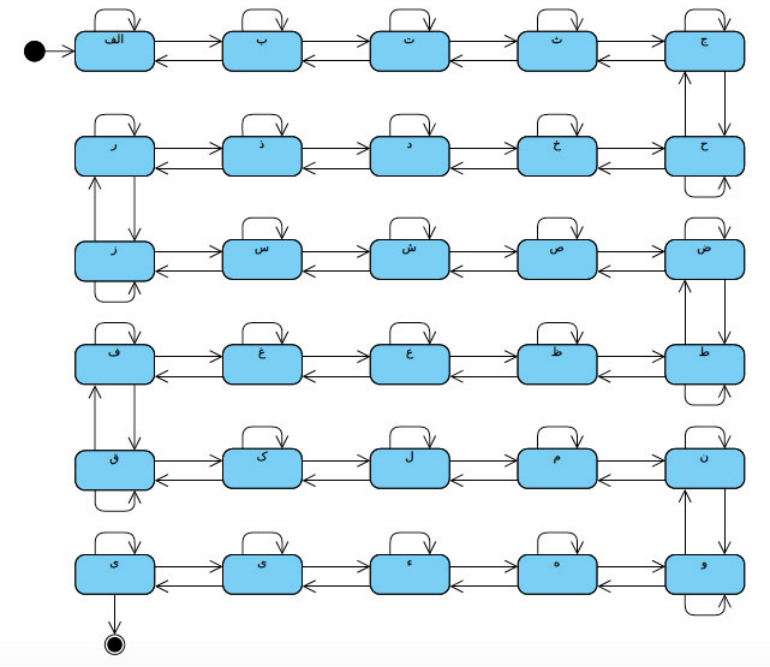

Figure 6.16: An Example of First Map State Machine

6.5.2.1 Speech Recognition System

On each outlet pronunciation trial, the child pronounces, as shown in Figure 6.17, the system writes what the child said, then the system compares it to the database to check if it is correct. It is a very powerful system automated by Google.

We used Google Speech API for two reasons, which are stated in (89). Firstly, Google API achieved 9% WER (Word Error Rate) in comparison to some open sources speech recognition systems and Microsoft API. Secondly, Google has improved its API with many applications including voice actions, voice input, voice search on mobile, and YouTube transcriptions.

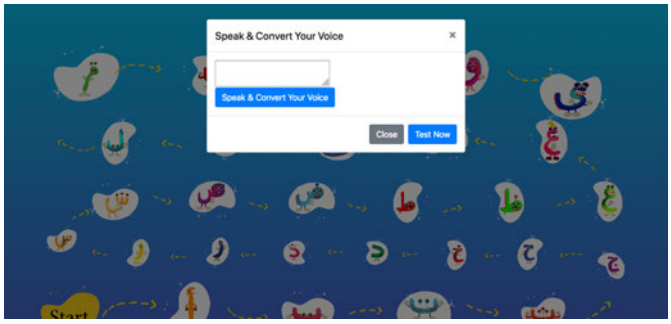

Figure 6.17: Speech Recognition System

6.5.2.2 Reinforcement Mathematical Model

An important challenge in the Qur'anic education system is to determine how to adapt the curriculum sequence to each student according to their learning characteristics. Several Machine Learning (ML) techniques are used in other education systems for students in order to choose the best pedagogical strategy to be applied in each moment, like neural networks, Bayesian networks, etc. In the Qur'anic education system, the system must be able to improve its pedagogical policy, sequencing the system's content in an accurate way according to the current student's needs based not only on the student's performance, but on lesson objectives and the relationships among course modules. To provide these capabilities in an education system, reinforcement learning has been widely used in the literature (61, 62, 63, 64, 65). However, to the best of our knowledge, this is the first research that uses reinforcement learning for evaluating non-native Arabic children in their Qur'anic education.

Reinforcement learning (RL) is an aspect of Machine learning where an

agent learns to behave in an environment, by performing certain actions and observing the rewards/results which it gets from those actions (90, 91). Reinforcement learning refers to learning what to do — how to map situations to actions — to maximize a numerical reward signal. A learning agent can take actions that affect the state of the environment and have goals relating to the state of the environment. One of the challenges that arise in reinforcement learning, and not in other kinds of learning, is a trade-off between exploration and exploitation. Of all the forms of machine learning, reinforcement learning is the closest to the kind of learning that humans and other animals do.

Other than the agent and the environment, one can identify four main sub-elements of RL, as shown in Figure 6.18:

- **Policy:** is a mapping from perceived states of the environment to actions to be taken when in those states. The policy is the core of a reinforcement learning agent in the sense that it alone is sufficient to determine behaviour. It may be stochastic, specifying probabilities for each action.

- **Rewards:** On each time step, the environment sends the reinforcement learning agent a single number called reward. The agent's sole objective is to maximize the total reward it receives in the long run. The reward signal, thus, defines what the good is and what the bad signals are for the agent. It may be a stochastic function of the state and action.

- **Value Function:** specifies, roughly, the value of a state of the total amount of reward an agent can expect to accumulate over the future, starting from that state. Although rewards determine the immediate, intrinsic desirability of the environmental states, values indicate the long-term desirability of states after taking into account the states that are likely to follow and the rewards available in those states. For example, a state might always yield a low immediate reward but still have a high value as it is regularly followed by other states that yield high rewards, or the reverse could also be true.

- **Model of the environment:** this mimics the behaviour of the environment, which allows inferences to be made about how the environment will behave. For example, given a state and an action, the model might predict the resultant's next state and next reward. Methods for solving reinforcement learning problems that use models are called model-based methods, as opposed to simpler model-free methods, trial and error learners.

Figure 6.19 shows a part of the state machine we generate for each map in the learning system. In this state machine, there is a state corresponding to each WORD/outlet in the learning system. Each map contains a starting state and an ending state. A speech recognition system is activated and responsible for rewards and punishment.

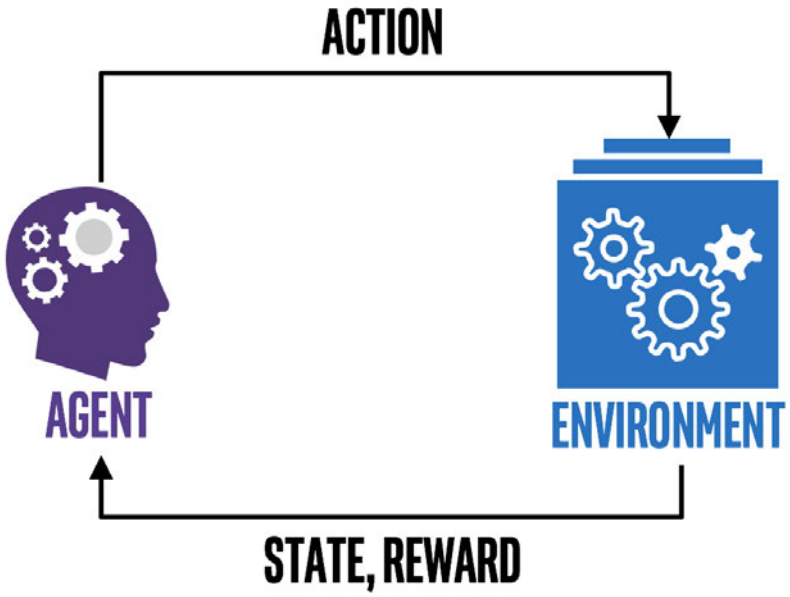

Figure 6.18: The Main Elements of a Reinforcement Learning Model

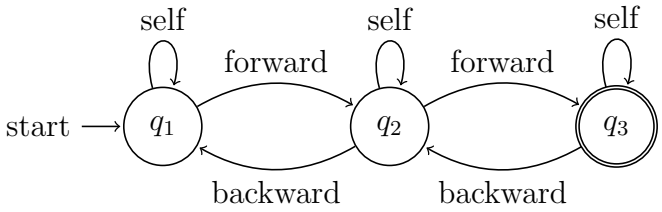

Figure 6.19: Part of the State Transition Machine

Here are the notations we used in this model:

- q: is a state in the state machine which is corresponding to a WORD in the map
- t: from 0 to T The number of times a child needs to pronounce 1 Char
- $r_t(q)$: amount of reward obtained by the student at time t and state q

- α is a constant value to adjust the computation of the average rewards
- $Q_t(q, a)$: A value we assign to action a at time t in state q.
- $\pi_t(a)$: the probability of choosing action a at time t.
- β is a constant value to adjust the computation of action values

The amount reward is set to each state of the machine. The initial value of this reward is set to zero and then it is reinforced based on the answers received from the student. The student's answer is the result of the child's pronunciation obtained from the speech recognition system. More specifically, the reward is positive if the student's answer is correct, and the reward is negative if the student's answer is incorrect. Here is the formula for this computation:

$$r_t(q) = \begin{cases} c, & \text{for answer}(t) = True \\ -1 \times c, & \text{for answer}(t) = False \end{cases} \tag{6.1}$$

where c is constant value set by the system administrator, and answer(t) is a function for defining the result of pronunciation question asked from the student at time t. The output of the answer(t) is $True$ if the student pronounces the word correctly at time t and the output of the answer(t) is $False$ if the student pronounces the word incorrectly at time t. So, we have: $r_t(q) = 0 \quad$ for $t = 0$.

$$\text{answer}(t) = \begin{cases} True, & \text{student's answer is correct} \\ False, & \text{student's answer is incorrect} \end{cases} \tag{6.2}$$

We compute the average reward for each state according to the answers obtained from the student. Here is the computation for the average reward at time t:

$$\bar{r}_{t+1}(q) = \bar{r}_t(q) + \alpha[r_t(q) - \bar{r}_t(q)], \quad when \quad \bar{r}_t(q) = 0, \quad \text{for } t = 0 \tag{6.3}$$

It is to be noted that r_t is directly obtained from the correctness of the child's answer.

Now we update the action value for every possible action we have at the current state. It is to be noted that we force the student to stay at the current state for the first three iterations. During the first three iterations, the student only earns the rewards according to his/her answers to the questions. Thus, we update the action value in the way that the student is forced to stay in the current state, and accordingly choose the action *self*. Thus, we suggest the following computations for the action values in the first three iterations:

$$Q_t(q, a = self) = 1 \quad \text{for } t = 1, 2, 3 \tag{6.4}$$

$$Q_t(q, a = forward) = 0 \quad \text{for } t = 1, 2, 3 \tag{6.5}$$

$$Q_t(q, a = backward) = 0 \quad \text{for } t = 1, 2, 3 \tag{6.6}$$

After the third iterations, we employ a randomised mechanism to choose the next state according to the action value. Thus, the action values after the third iterations are computed based on both the average reward and the answer from the student. Here are the computations:

$$Q_t(q, a = forward \mid \text{answer}(t) = True) = \bar{r}_t(q) + \beta[r_t(q) - \bar{r}_t(q)] \quad (6.7)$$

$$Q_t(q, a = self \mid \text{answer}(t) = True) = \bar{r}_t(q) - \beta[r_t(q) - \bar{r}_t(q)] \quad (6.8)$$

$$Q_t(q, a = backward \mid \text{answer}(t) = True) = \bar{r}_t(q) - \beta[r_t(q) - \bar{r}_t(q)] \quad (6.9)$$

$$Q_t(q, a = forward \mid \text{answer}(t) = False) = \bar{r}_t(q) - \beta[r_t(q) - \bar{r}_t(q)] \quad (6.10)$$

$$Q_t(q, a = self \mid \text{answer}(t) = False) = \bar{r}_t(q) + \beta[r_t(q) - \bar{r}_t(q)] \quad (6.11)$$

$$Q_t(q, a = backward \mid \text{answer}(t) = False) = \bar{r}_t(q) + \beta[r_t(q) - \bar{r}_t(q)] \quad (6.12)$$

The probability of choosing an action a can be directly obtained from the actions' values. A very useful technique for this computation is using the Softmax formula where n is the number of possible actions to be chosen, as follows:

$$\pi_t(q, a) = Pr[q, a_t = a] = \frac{e^{Q_t(q,a)}}{\sum_{b=1}^{n} e^{Q_t(q,b)}} \quad (6.13)$$

6.5.2.3 The Softmax Function

The Softmax function (92) takes as input a vector z of K real numbers, and normalizes it into a probability distribution consisting of K probabilities proportional to the exponential of the input numbers. That is, prior to applying Softmax, some vector components could be negative, or greater

than one; and might not sum to 1. However, after applying Softmax, each component will be in the interval (0,1), and the components will add up to 1 so that they can be interpreted as probabilities. Furthermore, the larger input components will correspond to larger probabilities. The standard (unit) Softmax function $\sigma : \mathbb{R}^K \to \mathbb{R}^K$ is defined by the formula:

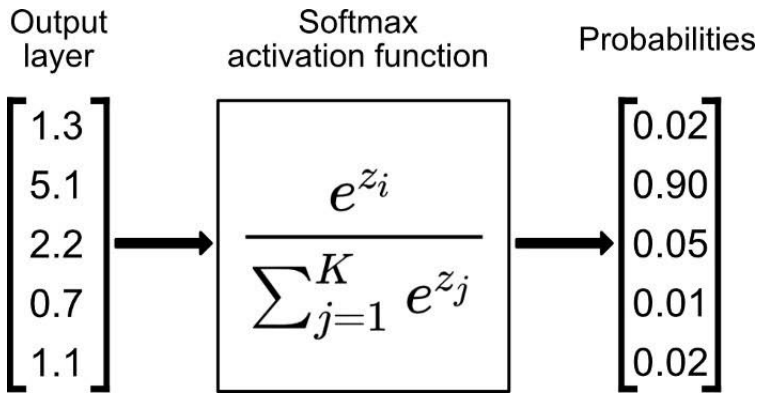

Figure 6.20: A Example of the Softmax Function

$$\sigma(\mathbf{z})_i = \frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_j}} \text{ for } i = 1, \ldots, K \text{ and } \mathbf{z} = (z_1, \ldots, z_K) \in \mathbb{R}^K \qquad (6.14)$$

It states that we need to apply a standard exponential function to each action value, and then normalize these values by dividing by the sum of all the exponential. Doing so ensures the sum of all exponential values adds up to 1. Figure 6.20 provides a useful example to show how the Softmax function works.

6.5.2.4 Comprehensive Example for Reinforcement Computations

In this section, we provide a comprehensive example to show how the reinforcement learning algorithm works in the proposed Qur'anic education system. In this example, we simply assume that the education system has only three states, starting at time $t = 0$ and state $q_1 =$ "$ALEF$", which is the first outlet in the map provided in Figure 6.16, as shown in Figure 6.21.

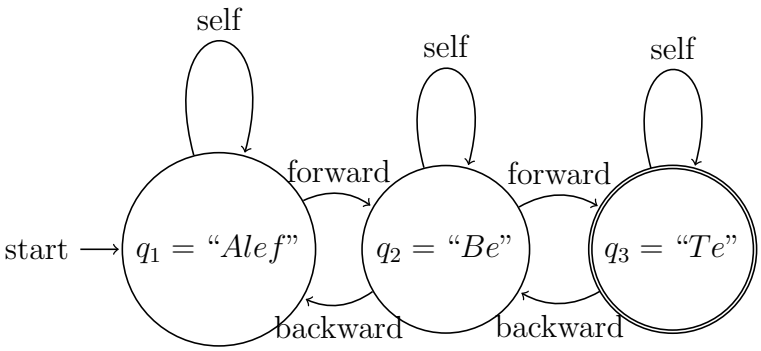

Figure 6.21: An Example of the State Machine with the First Three State in the First Map

In order to show the detailed computations of the equations in our reinforcement model, we need to make some assumptions about the answers of the student for the three states in the sample state machine. Thus, we assume 8 attempts and answers for the student. Table 6.1 shows the assumed answers from the student per each attempt.

Table 6.1: Answers of the student in our example. F: False and T: True

Time	0	1	2	3	4	5	6	7
Answer	F	T	T	F	F	T	F	T

It is to be noted that, for the first attempts, we force the student to stay

Table 6.2: Detailed computations in the simple example.

t	answer(t)	q_t	$r_t(q)$	$\bar{r}_{t+1}(q)$	$Q_t(q,a)$	$\pi_t(q,a)$	q_{t+1}
$t=0$	F	q_1	-2	-0.8000	$\begin{bmatrix}1 & 0 & 0\end{bmatrix}$	$\begin{bmatrix}0.58 & 0.21 & 0.21\end{bmatrix}$	q_1
$t=1$	T	q_1	2	0.3200	$\begin{bmatrix}1 & 0 & 0\end{bmatrix}$	$\begin{bmatrix}0.58 & 0.21 & 0.21\end{bmatrix}$	q_1
$t=2$	T	q_1	2	0.9920	$\begin{bmatrix}1 & 0 & 0\end{bmatrix}$	$\begin{bmatrix}0.58 & 0.21 & 0.21\end{bmatrix}$	q_2
$t=3$	F	q_2	-2	-0.2048	$\begin{bmatrix}0.5133 & -0.9229 & -0.9229\end{bmatrix}$	$\begin{bmatrix}0.68 & 0.16 & 0.16\end{bmatrix}$	q_2
$t=4$	F	q_2	-2	-0.9229	$\begin{bmatrix}0.5133 & -0.9229 & -0.9229\end{bmatrix}$	$\begin{bmatrix}0.6777 & 0.1612 & 0.1612\end{bmatrix}$	q_2
$t=5$	T	q_2	2	0.2463	$\begin{bmatrix}0.2463 & -2.0921 & -2.0921\end{bmatrix}$	$\begin{bmatrix}0.8382 & 0.0809 & 0.0809\end{bmatrix}$	q_3
$t=6$	F	q_3	-2	-0.6522	$\begin{bmatrix}1.1448 & -0.6522 & -0.6522\end{bmatrix}$	$\begin{bmatrix}0.7510 & 0.1245 & 0.1245\end{bmatrix}$	q_3
$t=7$	T	q_3	2	0.4087	$\begin{bmatrix}0.4087 & -1.7131 & -1.7131\end{bmatrix}$	$\begin{bmatrix}0.8067 & 0.0967 & 0.0967\end{bmatrix}$	q_4

in the first state which is state q_1 in our example, as shown in Figure 6.21. Moreover, at each time, the student obtains a reward value based on the success of his/her answer. For aggregating the rewards, we defined average reward at time t, denoted as $\bar{r}_{t+1}(q)$, and computed using Equation 6.3. Thus, for each time, $t = 0, 1, \ldots, 7$, we compute answer(t), $r_t(q)$, $\bar{r}_{t+1}(q)$, $Q_t(q,a)$ and $\pi_t(q,a)$. We also set $c = 2$, $\alpha = 0.4$ and $\beta = 0.4$ for this example.

Table 6.2 illustrates the trace results of the computations in our reinforcement learning model. In this table, we report the computation results for all equations at each time the student has a pronunciation attempt. The values for both $Q_t(q,a)$ and $\pi_t(q,a)$ are shown in a row vector format to summarise the table content. For example, in the first row of the table, where $t = 0$, we have $Q_t(q,a) = \begin{bmatrix}1 & 0 & 0\end{bmatrix}$ which means $Q_t(q, a = self) = 1$, $Q_t(q, a = forward) = 1$ and $Q_t(q, a = backward) = 1$. Moreover, in the first row of the table, where $t = 0$, we have $\pi_t(q,a) = \begin{bmatrix}0 & 0 & 1\end{bmatrix}$ which means $\pi_t(q, a = self) = 1$, $\pi_t(q, a = forward) = 1$ and $\pi_t(q, a = backward) = 1$.

More details about the computations of the above equations at time

$t = 0$ are as follows:

$$\begin{aligned}\bar{r}_1(q) =& \bar{r}_0(q) + 0.4 \times [r_0(q) - \bar{r}_0(q)] \\ =& 0 + 0.4 \times [-2 - 0] \\ =& -0.8\end{aligned} \tag{6.15}$$

$$\begin{aligned}\pi_0(q, a = self) =& \frac{e^{Q_t(q,a=self)}}{\sum_{b=1}^{n} e^{Q_t(q,b)}} \\ =& \frac{e^{Q_t(q,a=self)}}{e^{Q_t(q,a=self)} + e^{Q_t(q,a=forward)} + e^{Q_t(q,a=backward)}} \\ =& \frac{e^1}{e^1 + e^0 + e^0} \\ =& 0.5761 \\ \pi_0(q, a = forward) =& 0.2119 \\ \pi_0(q, a = backward) =& 0.2119\end{aligned} \tag{6.16}$$

It is to be noted that after computing the values of $\pi_t(q, a)$ for all three actions in the current state, we have the probability of choosing the next state. For example, at state $t = 0$, the highest probability for choosing the action in the state machine is $a = self$, which means the student will stay in the current state in the state machine. Thus, the next state is set to $q_{t+1} = q_1$, as shown in Table 6.2.

More details about the computations of the above equations at times

$t = 1$ and $t = 2$ are as follows:

$$\begin{aligned}
\bar{r}_2(q) =& \bar{r}_1(q) + 0.4 \times [r_1(q) - \bar{r}_1(q)] \\
=& -0.8 + 0.4 \times [+2 - (-0.8)] \\
=& 0.32 \\
\bar{r}_3(q) =& \bar{r}_2(q) + 0.4 \times [r_2(q) - \bar{r}_2(q)] \\
=& 0.32 + 0.4 \times [+2 - (0.32)] \\
=& 0.992
\end{aligned} \tag{6.17}$$

Now, the student is in the next state $q = q_2$, and the equations for computing the Q value is different. Thus, we compute the value as follows for $t = 3$:

$$\begin{aligned}
\bar{r}_4(q) =& \bar{r}_3(q) + 0.4 \times [r_3(q) - \bar{r}_3(q)] \\
=& 0.992 + 0.4 \times [-2 - 0.992] \\
=& -0.2048
\end{aligned} \tag{6.18}$$

$$
\begin{aligned}
Q_t(q, a = forward \mid \text{answer}(t) = F) =& \bar{r}_t(q) - \beta[r_t(q) - \bar{r}_t(q)] \\
=& -0.2048 - 0.4 \times (-2 - (-0.2048)) \\
=& 0.5133 \\
Q_t(q, a = self \mid \text{answer}(t) = F) =& \bar{r}_t(q) + \beta[r_t(q) - \bar{r}_t(q)] \\
=& -0.2048 + 0.4 \times (-2 - (-0.2048)) \\
=& -0.9229 \\
Q_t(q, a = backward \mid \text{answer}(t) = False) =& \bar{r}_t(q) + \beta[r_t(q) - \bar{r}_t(q)] \\
=& -0.2048 + 0.4 \times (-2 - (-0.2048)) \\
=& -0.9229
\end{aligned}
\tag{6.19}
$$

$$
\begin{aligned}
\pi_3(q, a = self) =& \frac{e^{0.5133}}{e^{0.5133} + e^{-0.9229} + e^{-0.9229}} = 0.68 \\
\pi_3(q, a = forward) =& 0.16 \\
\pi_3(q, a = backward) =& 0.16
\end{aligned}
\tag{6.20}
$$

The rest of the computations are very similar and the results of the implementation of the reinforcement are recorded in the learning model in Table 6.2. Implementation took place for the main part of the reinforcement learning model in Matlab 2016b. The source code of the implementation is shown in Figure 6.22.

```
answers=[0 1 1 0 0 1 0 1];
rprev=0;

for n = 1:length(answers)
    answer=answers(n);
    if answer == false
        rbar=rprev + 0.4*(-2-rprev);
        Q_forward= rprev - 0.4*(-2-rprev);
        Q_self= rprev + 0.4*(-2-rprev);
        Q_backward= rprev + 0.4*(-2-rprev);
        Q=[Q_forward Q_self Q_backward];
        P=exp(Q) ./ sum(exp(Q));
    else
        rbar=rprev + 0.4*(2-rprev);
        Q_forward= rprev + 0.4*(2-rprev);
        Q_self= rprev - 0.4*(2-rprev);
        Q_backward= rprev - 0.4*(2-rprev);
        Q=[Q_forward Q_self Q_backward];
        P=exp(Q) ./ sum(exp(Q));
    end
    disp(answer);
    disp(rbar);
    disp(Q);
    disp(P);
    rprev = rbar;
end
```

Figure 6.22: The Source Code of Our Implementation of the Reinforcement Learning Model in Matlab

In summary, the system consists of two main parts namely, the self-practiced and the virtual classroom. The self practice in short, encompasses Qur'anic education and Islamic education activities to be practiced at home, which gives parents a structure to help their children to get improved in a certain way. While the virtual classroom provides a mapping system to

improve the teaching experience. It improves the basic pronunciation via the Nooraniah Qaida program before moving forward. When difficulties are faced by students, the intelligent interactive model may help the student or have the teacher get involved in a complicated scenario. The mapping system is built based on the reinforcement learning mechanism, which helps to understand each child's difficulties and the stressors they face and attempts to improve them.

Chapter 7

Testing Phase and Analysis

This chapter presents a performance evaluation of the proposed system in order to validate its effectiveness and efficiency. As per the described methodological framework, the study was based on two rounds of evaluation with the participation of religious scholars and school teachers as well as allowing teachers to try the system on children for further results.

Besides this, to the best of our knowledge, we are the first to build a reinforcement learning and speech recognition system for Islamic education for non-native Arabic children based on both types of instructor's opinion. Unlike existing Islamic education technologies and Apps, we are the first to take into account the background, cultural, and pronunciation barriers that children are faced with.It is clear that we are the one of the first to focus on the Qur'anic education of non-native Arabic students. Such reinforcement learning is meant to be used when we have no prior knowledge about children, hence providing a fair and effective evaluating platform to understand their problems and address them accordingly.

7.1 Testing Methodology

The testing phase consisted of two rounds, namely, round 1: scholars and teachers feedback, and round 2: teachers feedback about the children. The main idea was to present the system for scholars and teachers in round 1, then adjust and optimise the system before proceeding to round 2 of testing.

During round 1 of testing, a qualitative study has been conducted with 4 scholars (4 Males) and 5 teachers (3 Females and 2 Males) after their consent was given for participation (consent details provided in Appendix D). The system for testing was provided for using a short presentation, video, and actual demonstration in 15 minutes as well as an open interview which was conducted in approximately 30 minutes. All the questions included are listed in Appendix B. Qualitative thematic coding is described in Section 7.2.

Apart from the extreme sensitivity of the topic and the target age of participants, also considering the fact of the current pandemic of COVID-19, the number of data size is quite small. According to (93), the increased amount of usability data that is collected from each person, the fewer participants that were needed. In Australia, the Arabic language is not the first or second language used, therefore finding other options were limited.

All selected scholars are work in Islamic centers in Australia and have been for over 5 years. They are involved with Islamic education and have completed research in the field. All the selected teachers are also involved in Islamic schools and teach early-age children Islamic education and run

Islamic classes for them.

In round 2 of testing, the system is given to three teachers and they are requested to select three students in their class to examine the system. This brings the number of participants to a total of nine students. Every teacher agreed and gave consent for the students' participation (see Appendix D). The selected students were well known to their teacher and fell into three different categories including: poor Performance, average Performance, and an excellent Performance. The actual system was given to teachers along with some survey questions presented in Appendix C. Each student's examination took about an hour to complete via the survey by their teachers. Analysis and results can be found in Section 7.3.

7.2 Round 1: Scholars' and Teacher's Feedback

Round 1 involved the participation of instructors in the design of the test and the evaluation of the real-life experiences that were observed in the research.

In general, both teachers and scholars were positive and welcoming in engaging with our research project and offered to provide long term assistance in our endeavours. In this section, we present some of the main themes that emerged from the discussions with both scholars and teachers. We also present quotes from our group of participants, where T_ID refers

to a primary school teacher and S_ID refers to a religious scholar.

In the initial study phase, our qualitative study 1 (See Appendix A) consists of questions made for an open interview with scholars and teachers to mainly observe their feedback about the system, to ensure whether their opinion have ever been taken into consideration, and to provide recommendations on how to improve the system.

A short presentation about the system and its features were given before showing the actual system; following some questions which were discussed, where the outcomes were analysed in the following subsections.

All teachers and scholars selected for the analysis have wide experience in Qur'anic education, Islamic education, and teaching. Also, they have high numbers of students/children which they educate every year. However, the qualitative study comments should be considered in isolation and may not be used as generalized statements.

The following table shows the summary of the themes to explain the subsequent subsections of the analysis.

Table 7.1: Themes Summary

Theme	Category
7.2.1 Feedback (System and Technology)	7.2.1.1 Speech Recognition
	7.2.1.2 Reinforcement Learning
	7.2.1.3 General Comments
7.2.2 Feedback (Children and Evaluation)	7.2.2.1 Assessment
	7.2.2.2 Fair Evaluation
7.2.3 Feedback (Method and Teaching)	7.2.3.1 Improvement Curve
	7.2.3.2 Time Saving and Consuming
7.2.4 Opinion Consideration and Recommendation	7.2.4.1 Research Involvement
	7.2.4.2 Some Recommendations

7.2.1 Feedback on System and Technology

In this theme, the main focus was on feedback about the system features, where the main module is the reinforcement learning model, and the system's backbone is the speech recognition system.

7.2.1.1 Speech Recognition (SR)

This module is a system capable of transferring the human voice into written text, which then compares it to the database entity to decide whether it is

correct or not. In other words, the system can listen, understand, and provide real-life feedback immediately to its users.

The religious scholars believe that SR plays two main roles. The first one is to be an assistant to the teacher to help students, while it allows students to correct themselves, as it has great accuracy. It was stated:

> *"The virtual class is an aspect that I like, specifically in its speech recognition. It'll help the verbal aspect of teaching and ensure that the student is pronouncing correctly, allowing the teacher to be able to help adjust or improve students' speech."[S3]*

Another teacher believes that voice recognition is a great feature which depends on the accuracy to discover students' mistakes. Teachers and scholars enjoyed the SR system as they stated that it was smart to take the Nooraniah Qaidah as a basis since repeating the whole verse can make it harder to find pronunciation mistakes.

> *"Voice recognition is great if it has great accuracy too"[T1]*

> *"This system has many great features, but the best one is the speech recognition"[T2]*

Speech recognition may stand alone whenever great accuracy is provided, however dealing with children always poses as a challenge. We propose the Intelligent Avatar Movement Model to provide greater support to the SP, which focuses on changing the voice transfer into an interactive role between the child and the system, as shown below:

"Another benefit of the system is that the speech recognition system is supported by showing where the word is coming from inside the mouth, as I use to ask students to look at my mouth to see how I am pronouncing it."[T5]

Teachers and scholars' approach when a student is unable to pronounce a word is usually to ask the student to look at their mouth to find where is the letter/word coming from.

"The most interesting features are the speech recognition and the smart pronunciation feature is after 2 failures."[T5]

Another teacher thinks it is very beneficial in a case like COVID-19, where studying online over distances can take place.

"This system is very beneficial, and it helps students learn a language from a distance easily and in an interactive way."[T2]

The teachers think that regardless of how good the system is, actual real classes are still mandatory, as stated below.

"It is based on voice recognition and, from my past experience, it's not always accurate. There still needs to be a weekly live interactive session with the teacher to evaluate the progress and not solely rely on the program."[T1]

Teachers agreed that providing a fair system to evaluate all students under the same circumstances is hard especially in large classes. Such a system is solving a significant issue in collaborative learning, as stated below:

"One of the complicated and challenging tasks on face-to-face learning is that each class has many different levels; however, using this method will solve this issue."[T2]

7.2.1.2 Reinforcement Learning (RL)

In our state machine, the first three main maps as described in section 6.3 are to build background data about each child to state their strengths and weaknesses.' The fourth map and onwards are dynamically generated to improve the child in the parts which suffer from the most failures.

The teachers and scholars were fascinated about the idea of the RL and how it maps the Nooraniah Qaidah instead of the whole verse:

"The most I like: the feature of mapping the Noorani Qaidah."[S4]

Another thought about teaching the verses in chunks:

"As in a weakness I am not sure how the system will recognise the student's pronunciation mistakes, especially when it comes to pronouncing a whole verse. That's why I think it is very smart to focus on Nooraniah Qaidah because it breaks down things into smaller chunks."[T4]

Again, mapping outlets from Noorani Qaidah were supported by the Intelligent Avatar Movement Model after two failures and the teacher alert after five failures, which are very beneficial in bringing the best out of children, as indicated below:

> *"Maps and showing how letters are pronounced and written, and listening to the correct spelling and pronunciation of the letters and words provide support to the students when making mistakes. In addition to this, it is so beneficial when the system interferes to correct after two mistakes and then calling the teacher to help after 5 mistakes."[S4]*

Articulation points in the Arabic language are very important as they may help in many verses and reading materials.

> *"I like the videos that explain how to pronounce the letters from its articulation points and how there are stages to teach if you make mistakes."[T1]*

7.2.1.3 General Comments on System and Technology

In a pandemic, like COVID-19, moving to an online system is a significant necessity and highly imperative. Reinforcement learning and speech recognition systems can provide great assistance to teachers, and on the other hand, to parents, as stated below. However, due to other factors which will be stated in the next section, the most beneficial outcomes are for the children themselves when they use such an interactive smart system.

> *"The idea of switching to virtual classes is wonderful, in such a pandemic, such that online remote learning with the student away from schools for any reason is made possible and beneficial with such a system."[S1]*

Keeping students' performance up to date is an important matter for teachers, as stated:

> *"I believe that having this kind of solving the communication between the teacher and the student is very important and will help a lot, and I have seen it is a very safe class environment as well for the duty of care of teaching and follow up with the student work and reinforcement strategies and how to assess and know the level of the student before, during, and after the class."[S1]*

One of the scholars thought that the idea was brilliant as it saved a significant amount of time compared to real classes.

> *"The software is very excellent and seems it took significant time to come up with this brilliant idea. Too much work and a big effort to bring such a system. Very interactive program."[S2]*

Qur'anic education is a significant part of Islamic education and practices. Learning a language, in some aspects, means learning a culture. Likewise, Qur'anic education in our proposed system is supported by and with other Islamic practices such as wuḍū and pray.

> *"In regards to the Qur'an and teaching stuff like wuḍū or pray, it looks professional and comes from trusted sources to reduce the number of mistakes or typos."[S2]*

Islamic education and Qur'anic education are closely related to each

other and will allow students to learn a lot and establish connections between the two.

> *"Self-practising and listening to reciters are also great aspects to improve pronunciation, recitation and achievement. In regard to Islamic education, the pictures, movements and explanation are so great to teach students the contents on the hope that there would be an agreement between what is taught in class and what is in the system." [S4]*

In 2021, technologies are the pillar of our lives. Relying on a system may let a student lose social interaction as stated below, but during a pandemic and the cultural changes occurring for a child, such a system is essential.

> *"The downside to this is the more we use technology to teach, the more students become reliant on it. In doing so, how are they still able to maintain confidence in social interactions? They are already currently using technology for their day-to-day schooling so wouldn't this be too much for them if their Qur'an and Arabic studies were also online?"[S3]*

As we investigated earlier, technologies are occupying a significant time in a child's life. Bringing new sources of learning using those technologies will be easier and beneficial.

> *"The system is useful in this time and age. Children nowadays prefer new methods of learning, and are relying on technology as a learning source." [T4]*

7.2.2 Feedback on Children and Evaluation

In this theme, one of the main goals of the system is to provide a good system to assess children and evaluate them fairly. We show some evidence and quotes which prove the importance of the designed system.

7.2.2.1 Assessment

Teachers, on the first day of class, have no prior knowledge about children, especially about those from different backgrounds. They need to build some strategies to investigate the child's weaknesses and strengths as stated here.

> *"... to know the weaknesses and the weak points, where we need to work on more, where to enhance and have more strategic so these are mainly the features."[S1]*

However, this system allows teachers to know more about children and their performance, especially when it comes to the time taken and the increased number of students in a class. This system can act as a professional assistant to teachers as stated below:

> *"In actual classes, we suffer from seeing students twice a week for few hours; it only makes the improvement very slowly on students and it is not enough for us. The strongest feature about the program is that it considers very big assistance to the teacher and keeps improving students." [S2]*

Motivating and causing a big improvement is another feature of the system as proven with the below statement:

"This program can easily cause a very big improvement for students as well as motivate and encourage them." [S2]

Keeping the teacher in the loop and having both teachers and children running the same wheel is another thought as stated:

"The teacher is able to keep an eye out on the student's progress which would help them identify who would need more assistance or who is falling behind." [S3]

Evaluating every child in the class is a significant and time consuming task. The next quote brought us into a conclusion which is:

" From my experience, I have seen that planning a specific plan for every student in real life in a traditional classroom is very hard because we may have 30 students and we have to plan for every individual. Usually, we plan for three different levels and that's set. This software, I have seen, can cater for every student. So instead of having only assessing for the three levels, this program assesses 30 different students in 30 different ways and brings out 30 different outcomes. So I believe this program will extremely help in this matter." [S1]

7.2.2.2 Fair Evaluation

Fair evaluation allows all students to get the same exact assessment environment and same opportunity privately. Children are affected by their

background and language barriers which makes them react differently in a classroom setting. Some students are loud, outgoing, or shy to interact during the class, which makes the process of evaluating them take extra time. In a classroom, the process of evaluation starts from day one and becomes significantly hard on teachers as they have to get to know their students and divide them mainly into three levels; poor, average, and excellent, as mentioned below:

> *"... Inside the classroom, the teacher will divide students mainly in three levels: weak, mid, and best students in the class" [S1]*

Children from different backgrounds may react differently, while it may take a longer time to bring the best out of them, as stated here:

> *"The students, when they come, especially in the early ages, do not show their best from the first class. We have to encourage them. We have to motivate them and get the best out of them. It will take time." [S1]*

However, the system provides the same competitive environment for every child, which will bring the best out of them in one session and provide a fair go and evaluation for all, as stated here:

> *" But by using this program or simulator, it will give a fair go for everyone even the shy ones. Because they are inside their house, they are writing things, pronouncing things." [S1]*

This was a significant point as, during our study, we understood that children do not behave the same. Some children are shy and others are loud. They have different characteristics coming from different backgrounds. Thus, the next quote proves that this environment of having individually focused programs are healthy and promising for both students and teachers.

> *"With this software, you can know every student and how they are going easily without the environment of competition or environment for those who are shy in the crowd or who have a loud voice or who is quiet in the corner. This environment of having this individual focus program is very healthy for students." [S1]*

It is always hard and time consuming for teachers to evaluate all students and acquire good knowledge about each child's strengths and weaknesses.

> *" Making the assessment and evaluation for all students at one go is a very hard task, especially when we think about some students who are shy and some of them who are very easygoing. It is not an easy task and almost impossible for the teacher to figure out those kind of students in one class, where it may actually take a few weeks to find out their weaknesses." [T5]*

7.2.3 Feedback on Method and Teaching

7.2.3.1 Improvement Curve

As the scholars and teachers stated, improving the learning curve with students is usually very slow, but having such a system handy, will significantly increase that curve as indicated below:

> *"During the class, the improvement curve is very slow while using such a system which can provide very big assistance to significantly increase the improvement curve. This will minimize the time and effort divided by the teachers." [S2]*

While others agreed that it would be beneficial to have the system so that it can stand by itself and participate significantly in the improvement ratio, as stated below:

> *"The system is good and makes the students improve themselves by repeating and practising and learning from their mistakes..." [T3]*

The interactive communication between students and teachers is an extra bonus feature, which can keep the teacher involved and the improvement growth still increasing.

> *"Communication and interaction between the student and the teacher is a bonus, unlike other applications that lack this sort of communication."[T4]*

It is very important to keep track of the child's progress and ensure the progress to be up to date.

> *"This system allows the teacher to keep proper track of the student's progress and that will be extremely beneficial in helping each student improve and grow through his or her studies." [S3]*

7.2.3.2 Time Saving and Consuming

The teachers and scholars conclude that such a system is exceptional in saving time in the learning process and time-consuming efforts in delivering a material which will also be saved, as stated below:

> *"Any system in the world has strengths and weaknesses, with no exception. However, this system is great and amazing and minimizes a lot of time and effort, particularly for the teacher. It saves a lot of time and tracks their improvement while they are at home." [S2]*

It is not easy for teachers to give every child fair time for assessments due to the increased number of students in the classroom.

> *"It will save lots of time and would allow students to benefit more."[T2]*

Besides this, examining a large group of students at the same time allows teachers and scholars to save a significantly increased amount of time, which then needs to be spent with each individual, as stated below:

"It is a very great feature to examine a large group of students at the same time and gives me a report for every child to allow me to know the class performance and every student performance as well which, in areal actual traditional classroom, may take a significant time. It is impossible to give every child 1 minute to find out their performance, especially with children." [S2]

The system provides great assistance to teachers.

"It is very hard to deal with students having many different difficulties in one large class, but if we are able to create a feature or a system that is able somehow to group students with similar or close difficulties, it will help save time and direct efforts depending on the number of groups that are created." [S4]

Interestingly, a scholar stated that what he can achieve with students in two years, it would be achievable in one year using this system, as stated below:

"If I am in the classroom alone with students or in another classroom with students using the system. In the second option, there will be a very big improvement. For example, if I want to achieve my goal in a class in 2 years, by having such a system I can easily do it in one year." [S2]

"It allows the teacher to keep up with the student level and allows students to be given feedback on their progress." [T4]

Whatever can be done in a year, having such a system can be done in 6 months as teachers need to spend great amounts of time with every child to help them, considering the actual number of students in the classroom.

> *"Such a system will save a lot of time which personally I think what can be done in actual class in one year, I would do in 6 months when I have such a system."[T5]*

Taking into consideration the different barriers about children's background and language difficulties, teachers and scholars need more time to investigate their performance, where time could be significantly saved, as stated below:

> *"Children coming from different backgrounds, different language difficulties, different personalities, are very important factors to think of. I think the system will save significant time to bring the best out of those children."[T4]*

7.2.4 Opinion Consideration and Recommendation

7.2.4.1 Research Involvement

We believe that taking the teachers and scholars' opinion into consideration in the design phase to build up the system is very important as they have been directly involved with children in the classroom and face the current difficulties and challenges of their learning first hand. Most scholars and teachers have never been considered as part of this procedure, while others

build up their own website for recitation only. In such a pandemic, movements made to move to online learning were not easy to incorporate into Qur'anic education, especially with children in this instance, rather than with adults. Some quotes below show this:

> *"... we just use what is available in the market since the beginning of COVID-19, like Zoom or skype. With adults was easy but for kids your program is much better and more interactive and more monitoring of students' improvement and this is what I like most about your program." [S1]*

The fact is that dealing with children is very critical and different from dealing with adults, as shown below:

> *"But it is all about management, fees, homework, food, camera. For such virtual classes, dealing with the kids is completely different from adults."[S1]*

One of the main reasons to consider in this research is the involvement of both religious scholars and school teachers, as they are the main people facing the difficulties and challenges inside the classroom and their opinion is the most important to consider when building an effective system.

> *"Usually, programmers consider the management (manager, financial, etc.) but not teachers, to be honest with you. They take care of the principal, for example, but not the teacher who is actually facing the difficulty in the classroom."[S2]*

"I have not been involved in such a design; however, I have a website and an app which only concentrate on how to read and write."[T2]

7.2.4.2 Some Recommendations

One scholar suggests that a lesson plan is also needed.

"As a previous teacher to students, I need some help in lesson plans." [S1]

On the other hand, another scholar suggests to improve the rewarding system.

"If I am the owner of the system, I will think about the reward system more to encourage and motivate them to do more and more. The rewarding system is not costly for the target group age. I suggest that at a certain level, let's say every 200 coins, a certificate is issued for them and includes a new button beside the headings to show how many certificates have been issued." [S2]

One scholar suggests that a communication group between the teacher and some students is required.

"A feature that would allow the communication between the teacher and all the students as a class in addition to the existing individual communication between the teacher and only one student.

This provides a better approach to discussing problems and providing help and answers."[S4]

One teacher suggests that building more features in regards to Islamic education and having a shift towards a gaming method will attract children further.

"Have them building their own masjid by unlocking different types of building materials such as bricks, stained glass, pillars, similarly to Minecraft. This will keep the students motivated and having fun." [T1]

A few teachers thought of expanding the system to have writing activities and extra features for Islamic education.

"1. Add drawing and colouring feature for alphabet letters. 2. Add writing feature, to practice writing. 3. Add a certificate system for completing each stage; for example, when a student completes the wuḍū or completes half of the alphabet letters, they will get a certificate for encouragement. 4. Add sharing feature of the achievements." [T2]

"I will add the writing and some activities." [T3]

Some of the recommendations suggested by scholars and teachers can be implemented in future work such as a lesson planner, writing activities and drawing and coloring. While some other suggestions have been implemented

before, this provides a system to try these on children such as implementing group communication, a rewarding system, and certificates for students.

7.2.5 Results Summary

Religious scholars and teachers contribute in providing their feedback on the system and add some recommendations to improve the system. Overall, the system suits their needs and addresses solutions to the current challenges and difficulties they face in teaching. Such that:

- The system provides a great assessment tool to differentiate between students' performance.
- The system saves a significant amount of time for both teachers and students.
- The system increases the improvement ratio for students significantly.
- The system becomes a great assistance to teachers to ensure students are practising at home and levelling up.
- The system involves parents and gives them a very strong base to help their children at home.
- The system discovers the children's strengths and weaknesses, which helps the teacher to build a very strong record with each child in the class.

- The system is able to bring an accurate and up to date record for every student/child.

7.3 Round 2-Teachers on Children

In this phase, the system is given to teachers along with a questionnaire (See Appendix C) to try on children and fill the survey based on their observations. The main point is to check how children perform on Qur'anic education with and without the system.

7.3.1 Questionnaire

The questionnaire which was given to teachers to try on children consists of 16 questions. After a very well explanation of the system, each teacher requested to try the system on three well-known students. One with a poor, an average, and an excellent performance record, to complete the test under the teacher's observation and fill the survey. Overall, we had three teachers and 9 students.

The questionnaire was built based on a quality rating scale (Poor, Good, Average, Very Good, and Excellent). It contains some negative questions to check the validation of data entry by the teacher to avoid random entry. Each of the rating scales is treated as an entry which are worth numeric points (Poor=10, Good=20, Average=30, Very Good=40, and Excellent=50). All these entries are completed by the teacher after examining the child. For example, to test the child's performance before and after

using the system, the teacher gives a child a verse to read in question 2, then they try the system and provide the same verse to try again before answering question 3. As per school teachers advice, the categories of evaluation should refer to the number of mistakes such as, poor will be recorded based on 7 mistakes or higher, Good=6 mistakes or less than 4, Average= 4 mistakes, very good =3 mistakes, and finally recorded as excellent when 2 or less mistakes occur.

Questions shown in Table 7.2 have been designed to test a few attributes, which will be explained in the analysis subsection below. For example, one entry with the value of *Poor* equals 10.

Table 7.2: Survey questions and results

Situation	Poor=10	Good=20	Average=30	Very Good=40	Excellent=50	Total
The Student enjoy the idea of avatar selection and representation	0	0	0	40	400	440
The student performs in repeating the whole verse?	30	40	120	0	0	190
After trying the maps, the student repeats the whole verse?	0	0	90	120	150	360
The student finishes the three statics maps with some mistakes	0	100	120	0	0	220
After the fourth maps, the student repeats the entire test and overcome falling in same mistakes	0	0	30	160	200	390
The Student felt so excited about collecting coins and gain certificates	0	0	0	40	400	440
The student make wrong pronuncactions	30	100	30	0	0	160
After 2 failures, the student pronounce the outlet as it should using the intelligent Avatar Movement Model	0	0	90	120	150	360
In self Practice mode, the student understand how to make Wudu and Pray	0	0	60	280	0	340
The teacher aware of the child weaknessess	0	0	240	40		280
The teacher changed his state about the child performance	0	0	0	40	400	440
The teacher is satisfy with the system as a key tool of support	0	0	0	0	450	450
After trying the maps, the student repeats the whole verse badly?	70	40	0	0	0	110
After the fourth maps, the student Could NOT repeat the entire test and overcome falling in same mistakes	60	60	0	0	0	120
After 2 failures, the student could NOT pronounce the outlet as it should using the intelligent Avatar Movement Model	60	60	0	0	0	120
The teacher could NOT changing his state about the child performance	70	40	0	0	0	110

7.3.2 Results

In the given questionnaire, some questions are related to each other in order to bring out some interesting patterns. Such that, we focused on testing the child's performance before and after using the system. We also checked if the system was acting as the current existing applications and websites in repeating the whole verse over and over again compared to the learn-

ing Nooraniah Qaidia which focuses on chunks. Further checks focussed on the weaknesses, improving it before going to repeat the whole verse at once. Finally, teachers selected well-known students to examine the system, but surprisingly, they found areas on children that forced the teacher to reconsider the current level of those students.

The following subsections 7.3.2.1, 7.3.2.2, and 7.3.2.3, shows the results of each metric in detail.

7.3.2.1 Children Performance Before and After Using the System

In this test, questions 2, 4, 7, and 10 represent the child's performance in Qur'anic education before using the system, while questions 3, 5, 8, and 11 represent the child's performance after using the system. For example, the student's performance in reading the whole verse was compared to the student's performance after trying the maps then reading the same whole verse again.

The teacher examines questions 2 and 3 in the survey by providing a verse to students to read and then answers question 2. They allow the student to try the system before reading the same verse to answer question 3.

The teacher examines questions 4 and 5 in the survey by allowing the student to finish the static maps and counting the number of mistakes, then allows the child to improve by trying the fourth map before repeating the test and checks if the number of mistakes has been reduced.

The teacher examines questions 7 and 8 by checking the pronunciation improvement of an outlet after 2 failures when the intelligent avatar movement model provides some help.

Finally, the teacher examines questions 10 and 11 by checking if the teacher discovered new strengths and weakness areas of the child.

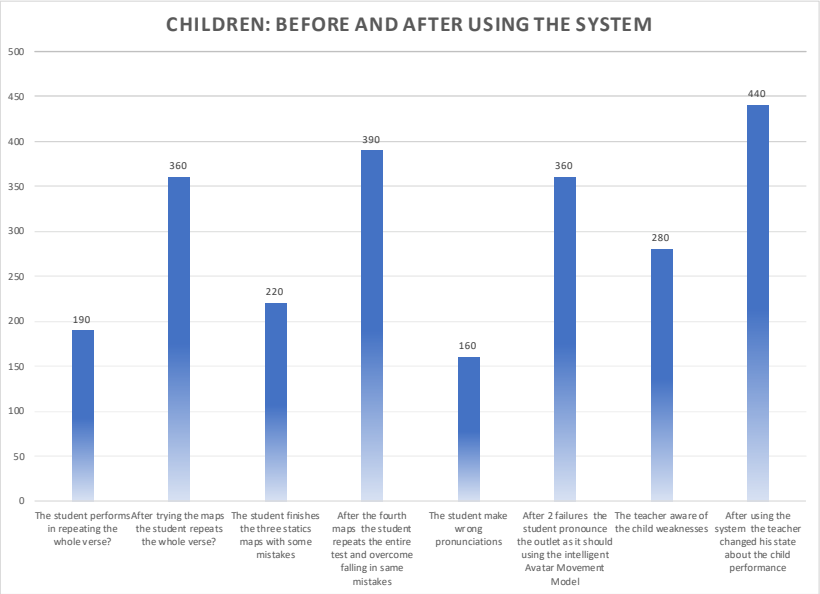

Figure 7.1: Children Performance Before and After Using the System

Figure 7.1 shows that the low bars are the questions that represent the child's performance before fully using the system while the long bars represent student's performance after using the system.

We notice that a significant improvement occurs in students' performance before and after using the system which amazed teachers and made

them confirm the improvement curve on children as well as the time-saving on such a teaching environment.

7.3.2.2 Nooraniah Qaidah vs. Whole Verse Metric

One of the research questions is to investigate teaching children the whole verse at once in comparison to the wording in chunks, where chunks are represented in our system into maps by Nooraniah Qaidah. Reading the whole verse in the Qur'an can be difficult, and we argue that teaching them chunks from the Qur'an can lead to better performance. Students in this test were given whole verses to try, then they were moved to try our maps which focus on certain chunks, where the whole verse was given again to find out the differences.

In this test, it is very clear that a significant improvement in children's performance was recorded when they read the whole verse compared to when they were taught chunks and had then repeated the whole verse again, as shown in Figure 7.2. This is proof of the feedback from teachers and scholars in round 1 about the feedback on the teaching method.

For clarification purposes, we did not test the whole verse in the system, but in this particular study, the teacher gave students a whole verse to test, then tried the system before repeating the whole verse again to check the differences.

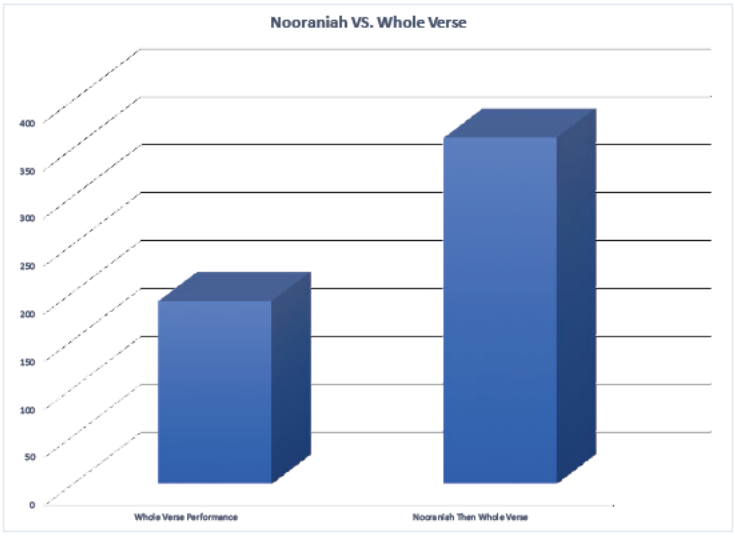

Figure 7.2: Nooraniah Qaidah vs. Whole Verse

7.3.2.3 Teachers Evaluation

Reinforcement learning deals with children who have no prior knowledge about their background and difficulties. The system is responsible to evaluate all students fairly. Some teachers and scholars from the testing phase of round 1, stated that this system is beneficial in giving a fair go and the same opportunity for all students to try for themselves, as some students could be shy and others very loud. It is hard for teachers to evaluate students in less than a month to find out where exactly they are having difficulties in their learning.

In this experiment, we asked the teachers to do the test on children who they are familiar with in terms of their performance. Therefore, they re-

quested to find out if they had discovered new weaknesses and strengths' which they did not recognise before. The results in Figure 7.3 show that every student who is examined brings a new discovery to the teacher's attention. As shown in the figure, the first bar 280 represents the entry for students' performance from the teacher's point of view, while the second bar 440 represents the entry for the teacher's status about the child which has increased, for the teacher to ascertain a weak or strong point in that child's learning.

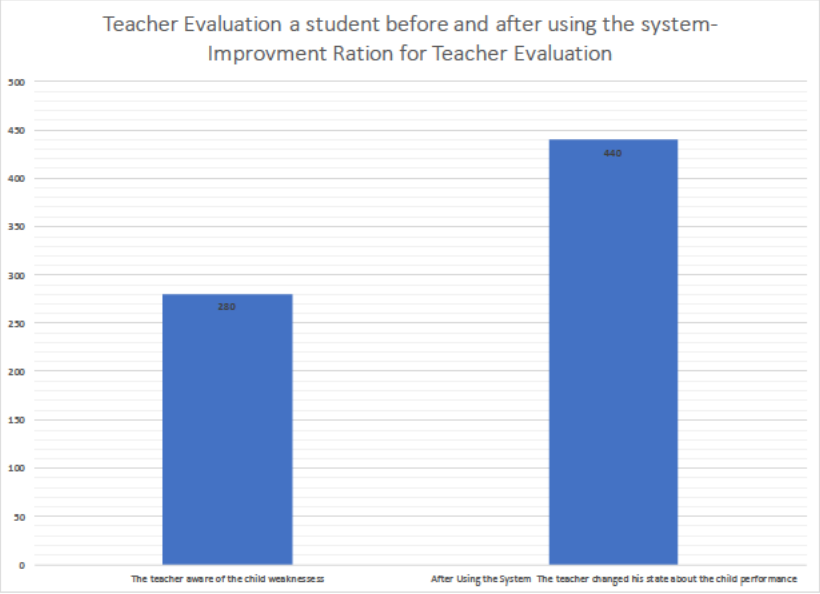

Figure 7.3: Teachers Evaluation Before and After Using the System

7.4 Discussion

This research focuses on improving the teaching experience of Qur'anic education for non-native Arabic children. It is a must to have teachers and religious scholars on board as they are facing the most of difficulties and class challenges whilst teaching students. After we collected data from them to design a system that is capable to overcome their difficulties in the classroom, we actually showed them the system after the design was completed to receive their feedback. They made suggestions during the data collection phase, however, after examining the system, it seems that the system brings some real challenges forwards. Despite these, time consumption, evaluation, assessment, and improvement ratios were the main components achieved from the system overall.

Non-native Arabic children from different background face many difficulties when it comes to Qur'anic education. Thus, cloud classrooms or virtual classrooms may have a significant impact on children and their performance in terms of evaluation, assessment, or improvement in Qur'anic education. (94). Cloud classrooms that depends on IoT devices may bring faster and better quality in achieving such purposes (94). We believe that our approach and results hint at this possibility also. Eventually, bringing the best out of each student in such a context seemed to be a real challenge and one that would take significant time; however, our system tackled this challenge and brought a fair evaluation with the same opportunity of every child such that the teacher became extremely confident about each child's

performance.

7.4.1 Research Limitations

During the period of completing this dissertation, we came across so many limitations and obstacles; specifically pertaining to the active research stage which can be summarised as follows:

- The main research work was focusing on providing the Virtual Reality (VR) application. Due to COVID-19 restrictions, re-scoping was mandatory. We solved this problem by providing a web-based simulator instead and left the VR application for future work.

- The main target group are children aged from 4 to 7 years old. It is a very critical age group. Due to difficulties in testing the system on them directly, we used teachers to act as proxies to handle the testing phase round 2, and provide the results for evaluation.

- We did not test complete verses for two reasons. Firstly, it was due to the target group age being critical, and the complexity of the Arabic language. Secondly, it was due to restrictions on accessing children ourselves due to ethical reasons as well as the prevailing pandemic.

Chapter 8

Conclusions and Future work

This thesis aims to provide a web-based simulator system to improve the teaching experience for both types of instructors, namely school teachers, and religious scholars, who are responsible for the Qur'anic education of non-native Arabic children. We have been through multiple studies conducted in Western Sydney, New South Wales, Australia. These were Qualitative Studies (1) for both types of instructors to collect data from to build the system and Qualitative Studies (2) for both types of instructors to give their feedback about the system. Further, a Quantitative Study (1) for teachers to try the system on children was also conducted. This is done based on the Center User Design approach.

We conclude this thesis based on the research questions stated in chapter 1, such that:

1. What learning mechanism is to be used which can provide a fair evaluation for children to understand their weaknesses and strengths whenever there is no prior knowledge about children especially in Qur'anic

education for non-native Arabic children?

- Since children come from different backgrounds, they suffer and react differently to a variety of language barriers. Reinforcement learning allows the system to provide a fair go for all children at once, and understand what needs to be improved. Significant improvement curve, time-saving, fair testing, and understand their difficulties to respond accordingly are the main characterises we found as a result of this research study.

2. What kind of combination in a system between an avatar and a teacher will create a proper reaction from students, especially if we agree that some are in favour and some prefer the teacher?

   - Both types of instructors agreed that this combination brought the best out of children and actually increased the improvement ratio significantly along with allowing time to be saved. Handling children performance and discovering the points of strengths and weaknesses seemed to be a remarkable issue for teaching, especially in terms of it being time-consuming and considering the large class sizes which were present. The final agreement on this is that, this was the best assisted system to teachers in the classroom, which indicates the improvement of the teaching experiences for them. We found that children are using the system and the avatar and representing them effectively, and once they

received a certain amount of failures, a teacher was going to be invited to the learning platform.

3. What are the characteristics of breaking down a verse into chunks, so that the system is able to figure out the children's difficulties?

    - Both types of instructors agreed that it was very smart to focus initially on Nooranih Qaidah instead of the learning of full verses. This was due to considering the fact that children coming from different backgrounds suffered from different difficulties and barriers. The effectiveness of the idea was also proven when teachers had tried the system on children in the classroom and had found significant improvements in their learning.

In a real life scenario, the system should work as an adjacent and hand tool to the real classroom and to teachers. However, in a case like the current pandemic, the system should also be able to stand alone to help teachers to continue the work of improving children's performances. The designed web-based simulator system can be deployed in the cloud or local infrastructure based on the school's needs.

Reinforcement learning has been used in education serving different purposes and needs to date (95). However, modelling the system and working out the RL mechanism for different purposes will bring a variety of results for both teachers and learners. For example, assigning educational activities in an online course like Algebra had brought a great results(96).

Suggesting further learning materials and continuous monitoring of student's progress during a course has also achieved satisfactory results via the reinforcement learning mechanism(62). Song Ju (97) evaluated critical reinforcement learning frameworks and finally concludes that RL has a gear success in environments such as e-learning.

Responding to such a pandemic like COVID-19, with such a system in place, can be extremely beneficial rather than using traditional online classrooms, especially for such a critical target group as this. For future work, virtual reality applications which can be implemented, may provide a better gaming structure and could bring more valuable outcomes to learning. Also, a study to compare between school teachers and religious scholars may lead to an interesting pattern about their focus while educating children. Finally, testing the system by trying complete verses and comparing it to the outcome from Noranih Qaida is a step to be taken for children older than our target group. This may provide an answer to what the accuracy of the speech recognition system is in Nooranih Qaida compared to the recitation of full verses from the Holy Qur'an.

The most difficult part of Islamic and Qur'anic education is the complication of the Arabic language itself. It would be very interesting to find out how this system's finding can be extended to another language and religion as we believe that some findings can be generalized and applied to other religious systems also.

Appendix A

Ethical Approval & Qualitative Study 1

WESTERN SYDNEY
UNIVERSITY

REDI Reference: H12880
Risk Rating: Low 1 - LNR

HUMAN RESEARCH ETHICS COMMITTEE

5 September 2018
Doctor Omar Mubin
School of Computing, Engineering and Mathematics

Dear Omar,

I wish to formally advise you that the Human Research Ethics Committee (HREC) has approved your research proposal H12880 "Mobile Technology and Islamic Education for Non-Arabic Children", until 5 October 2018 with the provision of a progress report annually if over 12 months and a final report on completion.

In providing this approval the HREC determined that the proposal meets the requirements of the National Statement on Ethical Conduct in Human Research.

This protocol covers the following researchers:
Omar Mubin, Mauricio Novoa, Bayan Alsharbi

Conditions of Approval

1. A progress report will be due annually on the anniversary of the approval date.

2. A final report will be due at the expiration of the approval period.

3. Any amendments to the project must be approved by the Human Research Ethics Committee prior to being implemented. Amendments must be requested using the HREC Amendment Request Form

4. Any serious or unexpected adverse events on participants must be reported to the Human Research Ethics Committee via the Human Ethics Officer as a matter of priority.

5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the Committee as a matter of priority

6. Consent forms are to be retained within the archives of the School or Research Institute and made available to the Committee upon request.

7. Project specific conditions:
There are no specific conditions applicable.

Please quote the registration number and title as indicated above in the subject line on all future correspondence related to this project. All correspondence should be sent to humanethics@westernsydney.edu.au as this email address is closely monitored.

Yours sincerely

[redacted]

Professor Elizabeth Deane
Presiding Member,
Western Sydney University Human Research Ethics Committee

WESTERN SYDNEY
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Qualitative Study 1: Initial Study To Scholars

Focus: The main focus on scholars based on Islamic education is to find out the difficulties on actual Quran teaching.

Target Group: Scholars involved in teaching Quran for young people

Open Interview

The main concept behind the open interview with scholars is that to investigate general opinion about certain concepts as stated in the following question.

1: How do you teach currently? Are you using any technology? What problems children have in terms of learning Quran especially when they are not Arab speakers?
2: What do you think the main challenges on actual classes and how it would be different if we use an App? How do you get them enjoyed?
3: How a child can memorize Surah?
4: What do you do when a child is stuck to read or understand something from Quaran?
5: Should we show some basic concepts in Islam, like pillars of Islam, salat, …etc?
6: Non-native young coming from different background have different pronunciation, how to ensure that they pronounce things as it should be? And how long it may take?
7: What interactive methods used in actual class? How much it helps?
8: If they got bored, what should be done to get them engaged again?
9: How is the lesson structure should be?
10: If I ask you to order the learning focus in sequence, what is the best order to be shown between, Memorize, Tafsir, Tajweed, Norani Qaid'a?

WESTERN SYDNEY
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Qualitative Study 1: Initial Study to Teachers

Focus: The main focus on Teachers on Islamic and educational technology is to find how a technology can be more affective, what challenges, difficulties, and background barries is there.

Target Group: Teachers involved in educational teaching

Open Interview

The main concept behind the open interview with scholars is that to investigate general opinion about certain concepts as stated in the following question.

1: How do you teach currently? Are you using any technology? What problems children have in terms of learning Quran using technology especially when they are not Arab speakers?
2: What do you think the main challenges of using technology in teaching Quran?
3: What do you think about Islamic technology? To which strength would it be accepted?
4: what are the main issues of cooperating technology and Islamic education?
5: Imagine an interactive App would be helpful? How student enjoyed?
6: What are the negative points of using technology in Islamic education? What are the fears?
7: In terms of percentage, how much you think a mobile (ipad) App should help in teaching Quran?
8: How a technology used in Islamic teaching such as Quran could be supervised?
9: What methods may be used in technology to help in memorizing and correct pronunciation?
10: What schemes can be used in technology to motivate children to use an App and use it correctly?

Appendix B

The Protocol of Testing, Round 1: Scholars and Teachers

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Testing Phase Protocol

This is the first round of testing phase meant for scholars (4) and teachers (4) where the entire system will be shown, and open verbal recorded interview will be conducted. The procedure of this phase is as follows.

1- Introduction

- Introduce myself, degree and university
- Show the propose of the meeting
- Explain the protocol of the interview
- Estimating time for this protocol is 30-45 minutes.
- The entire interview is voice recorded.

2- Consent Form

- Participants will be asked to read and accept then sign the consent form to proceed

3- Simulation

- A video will be show which show all the details of the work
- A computer will be handy if they wish to look over the system
- Discussion and Q&A will be conducted to make sure that the system features have been understood

4- Open Interview

- Few questions will be asked, and the participants kindly requested to answer

1. How useful do you think the system is? Strength and weaknesses! What are the benefits of the system from your point of view?
2. What do you think about the current features? Please specify what do you like most?
3. If you own the system! How would you improve it? What features would you add?
4. As a scholar/teacher, have you ever been consulted by a researcher to be involved in such a design for the same purposes?
5. At a certain level, the system will generate maps to children based on what difficulties they face! In actual classes how hard to do so with every child specially in large classes? How much time would be saved by having a system able to evaluate children in large classes?

Appendix C

The Testing Survey for Round 2: Teachers on Children

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Project Title: Mobile Technology and Islamic Education for Non-Arabic Children

Situation	Poor	Average	Good	V.Good	Excellent
The Student enjoy the idea of avatar selection and representation					
The student performs in repeating the whole verse?					
After trying the maps, the student repeats the whole verse?					
The student finishes the three statics maps with some mistakes					
After the fourth maps, the student repeats the entire test and overcome falling in same mistakes					
The Student felt so excited about collecting coins and gain certificates					
The student makes wrong pronunciations					
After 2 failures, the student pronounces the outlet as it should using the intelligent Avatar Movement Model					
In self Practice mode, the student understands how to make Wudu and Pray					
The teacher aware of the child weaknesses					
The teacher changed his state about the child performance					
The teacher is satisfied with the system as a key tool of support					
After trying the maps, the student repeats the whole verse badly?					
After the fourth maps, the student Could NOT repeat the entire test and overcome falling in same mistakes					
After 2 failures, the student could NOT pronounce the outlet as it should using the intelligent Avatar Movement Model					
The teacher could NOT change his state about the child performance					

Appendix D

Consent Form for Data Collection and Testing Phase

WESTERN SYDNEY
UNIVERSITY

Consent Form – General (Specific)

Project Title: Mobile Technology and Islamic Education for Non-Arabic Children

I hereby consent to participate in the above named research project.

I acknowledge that:

- I have read the participant information sheet (or where appropriate, have had it read to me) and have been given the opportunity to discuss the information and my involvement in the project with the researcher/s

- The procedures required for the project and the time involved have been explained to me, and any questions I have about the project have been answered to my satisfaction.

I consent to:

☐ *Participating in an interview*

☐ *Having the interview audio recorded*

I consent for my data and information provided to be used for this project.

I understand that my involvement is confidential and that the information gained during the study may be published but no information about me will be used in any way that reveals my identity.

Signed:

Name:

Date:

This study has been approved by the Human Research Ethics Committee at Western Sydney University. The ethics reference number is: H12880

What if I have a complaint?

If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through Research Engagement, Development and Innovation (REDI) on Tel +61 2 4736 0229 or email humanethics@westernsydney.edu.au.

Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

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